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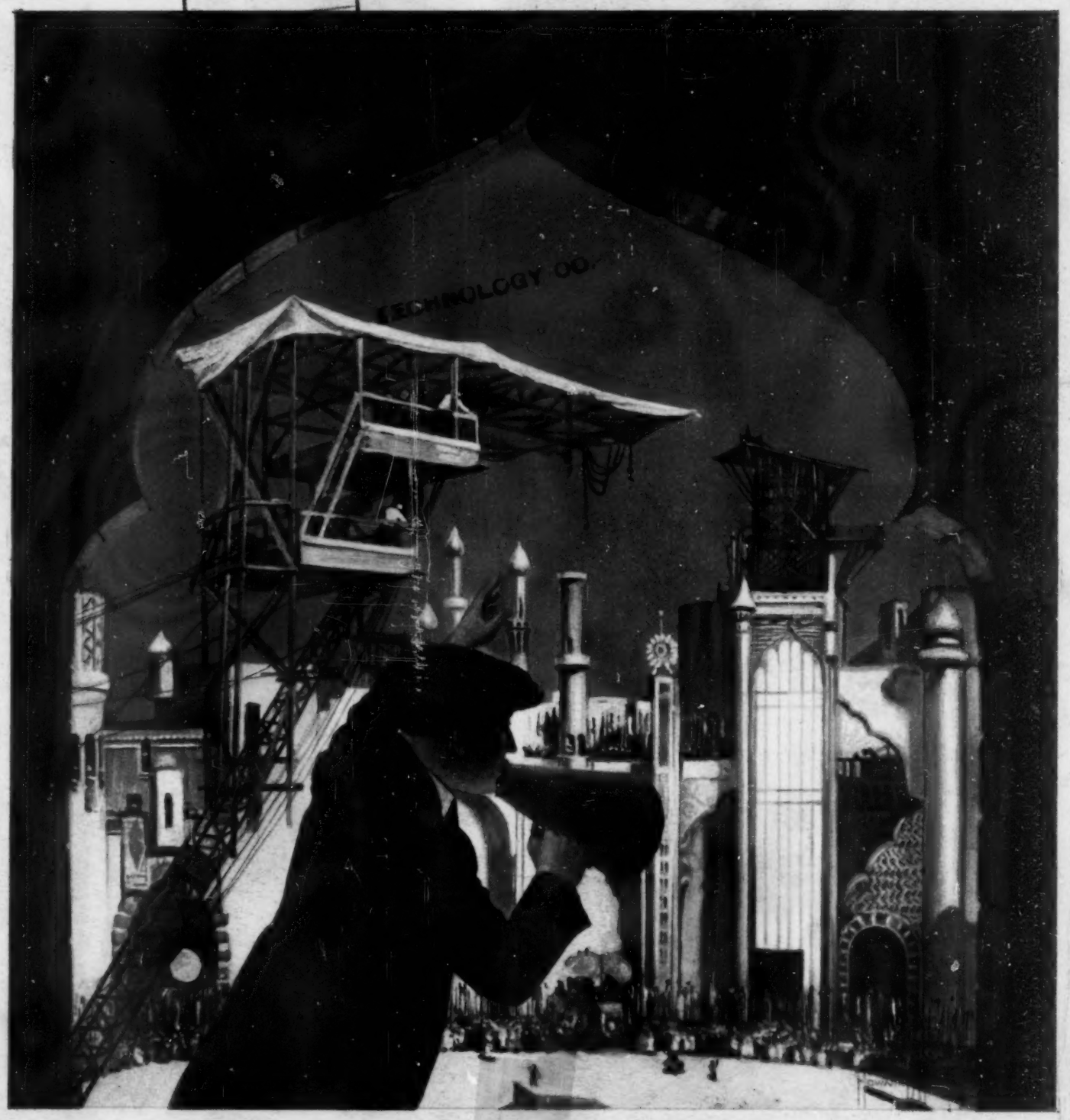
SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

RECEIVED FEB 28 1924 HILLS No. Class No.

35¢ a Copy MARCH 1924 $4.00 a Year



IN THE LAND OF MAKE-BELIEVE: AN AERIAL PLATFORM FOR CAMERAMEN.—[See page 169]

Scientific American Publishing Co., Munn & Co., New York

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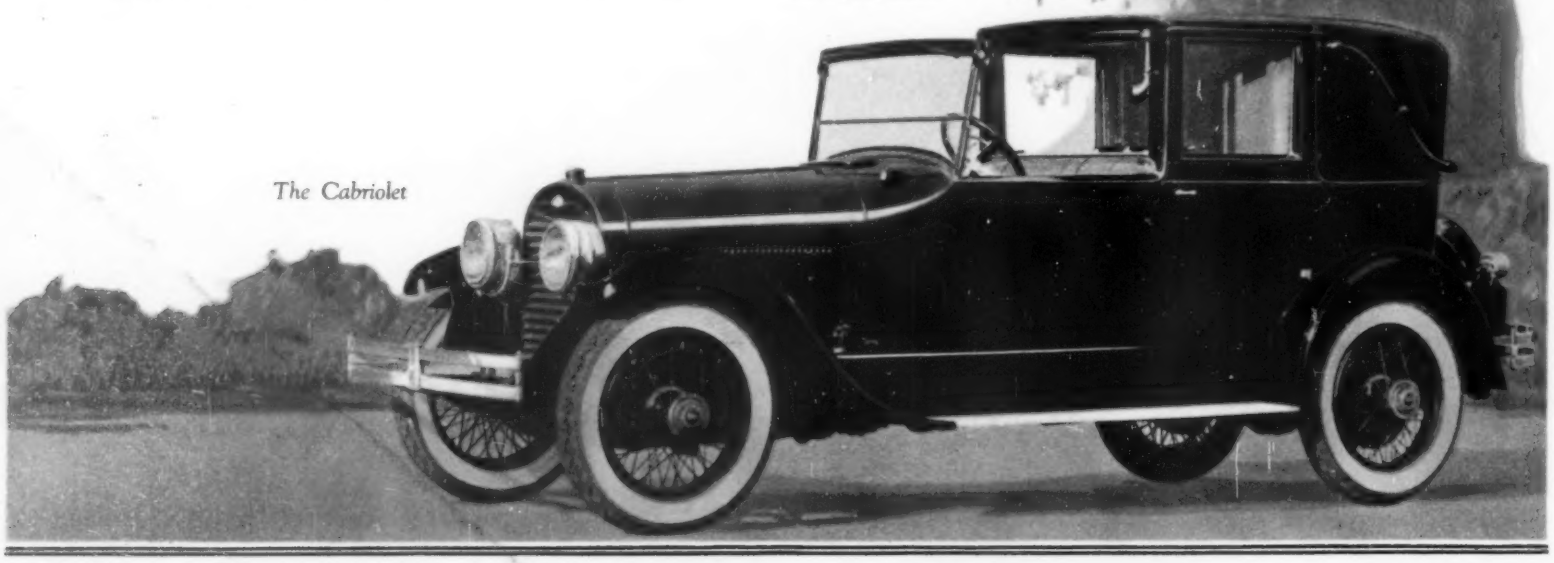

LINCOLN

With the Editors

OUR series of traffic articles has now reached the point where something in the direction of constructive suggestions is in order. We are not without resources in this direction. We have discussed the matter with various gentlemen, who, as administrators of the law or as delvers into the statistics, may be assumed to have opinions worthy of attention. But the main prerequisite for uniformity of law is cooperation. If there are existing agencies through which such cooperation between the states is in the way of being obtained, and if we go ahead without consultation with these agencies, we are quite as likely as not to run counter to their program. Their ideas might be better than ours, ours might be better than theirs; but whichever way this comparison might run, promulgation of our ideas in the face of theirs could only result in "spilling the beans."

AN admirable way turns up of avoiding this. On January 24th and 25th the Motor Vehicle Commissioners of ten Eastern States met in conference in New York. They do this fairly often—they have a permanent organization, in fact, through which they keep track of one another's troubles and one another's ideas. It was fairly obvious that at this conference material would be developed bearing upon our series, and equally that contact could be made by our editors with these various administrators. So we have held the third article of our series over until April, since we cannot wait until after the conference to write it, and still get it in the March issue. As we type these remarks, we have talked with three of the Commissioners, seen their conference in session, and are amply assured that our third article will be the better for the delay. It will probably be given over to a discussion of the organization, the aims and the procedure of the conference, and an indication of just what is to be accomplished by this voluntary banding together of the State administrative officers.

DR. ALFRED ABRAMS is dead; but the electronic system marches on. In at least one respect the death of the founder clears the atmosphere. No longer can it be claimed that only Abrams is competent to make a test on which judgment of his system shall be based. No longer can our investigation be footballed back and forth from the practitioner to Abrams, from Abrams to the practitioner. It will now be necessary for the electronic technique to stand on its own feet or ingloriously to fall. Which, the next few months will doubtless determine.

IN THE meantime, in far away Australia the Abrams treatment is breaking into the newspapers, inflaming the public mind, and absorbing the attention of dominion cabinets. Attention being focussed on the electronic diagnosis and treatment through a demonstration of some sort staged in New Zealand, the papers of Brisbane, Sydney and other continental cities demanded that their respective governments conduct an investigation. Medical opinion was sought by the authorities, and was of course adverse; whereupon the authorities dropped the matter. Not so the newspapers. Screaming headlines about governmental inertia and suffering humanity alternated with facsimile reproductions of cablegrams from Abrams himself, offering to extend help to an investigation "in any way possible"—our readers will observe a familiar note. Letters from people who have been cured of incurable cancers in a few days vie for position with other communications denouncing Abrams as a faker. The SCIENTIFIC AMERICAN investigation is quoted in numerous ways. One paper reproduces our opening article, in which we forecast a long and difficult investigation, and throws this into the teeth of the Australian doctors who presume to denounce Abrams more or less offhand. Governments are quoted as waiting upon the result of our investigation, prepared to abide by this result, and emphasizing the absurdity of duplicating our work. Abrams and the SCIENTIFIC AMERICAN are furnishing the major political issue of the moment in the Antipodes.

INCIDENTALLY, our Abrams investigation, as we go to press, is taking to the road. All over the country there are numerous investigators, some actuated purely by the desire to advance science, others we fear moved mainly by solicitude for their own finances, but all working hard in the effort to isolate and identify and reduce to order the elusive and chaotic forces which, if there be any truth at all in the electronic system, lie behind it. We shall call on a number of these gentlemen and let them exhibit to us just what they are doing. It may be that they will be able to show us something startling; it may be that we shall be able to upset their pots of gold and fracture their rainbows as completely as we have already done in the cases of one or two local researchers. But whatever the results of our contact with them, there will be an interesting story to tell.

AND while a section of the editorial staff is *en tour*, other things than the electronic reactions will come in for attention. We shall, for instance, visit the great engineering laboratories at Dayton, and we shall come away from them with a story following out our recent editorial "The automobile in the test-tube." For just as we had begun to flatter ourselves that the major problems of motor-car design were about settled, so that we might look forward to a period of comparative stability of type, these industrious scientists turn up some discoveries that give every hope of making present-day cars and present-day fuels and present-day practice look about as modern as the two-lungers of 1904, that recently staged an endurance race in the streets of New York. Of course, that doesn't mean that we should get panicky about the last-year's car that we have, or the this-year's car that we had thought of buying. The factory is always five years or more behind the laboratory in an industry that produces on such a quantity basis as does this one, and we may therefore be quite certain that, whatever the epoch-making innovations the next few months, they will come into actual commercial practice in such a way as not to affect the stability of the industry.

OUR traveling member will get as far west at Riverbank, Ill., where stand the magnificent laboratories described in a recent issue, the hobby of Colonel George Fabyan. We have already told about the laboratories, as such. Now we shall be able to put before our readers their specific work in sound, human hearing, X-ray therapeutics, and other interesting fields.

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SCIENTIFIC AMERICAN PUBLISHING COMPANY

Munn & Company, 233 Broadway, New York

Founded 1845

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Vol. 130, No. 3. Published monthly. Entered as second-class matter, June 18, 1879, at the post office at New York, N. Y., under the Act of March 3, 1879.

Price, 35 cents a copy. $4.00 a year. Postage prepaid in United States and possessions, and Mexico, Cuba and Panama; $4.50 a year for Canada. Foreign subscriptions, $5.00 a year, postage prepaid.

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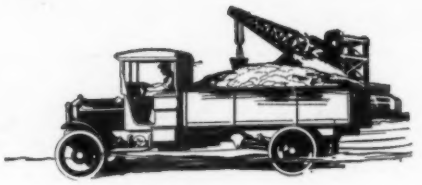

In the work of getting materials to the building job Federal Trucks are giving excellent service everywhere. The scene below shows a Federal 3½ ton operated by the American Concrete Company in San Francisco. It is because Federals are manufactured of the finest of steels and constructed on modern engineering principles that they operate economically and depreciate slowly.

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1½-Ton	2150	7-Ton	5000
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These prices are for standard chassis only, in lead—F. O. B. Detroit. Excise tax additional.

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EIGHTIETH YEAR

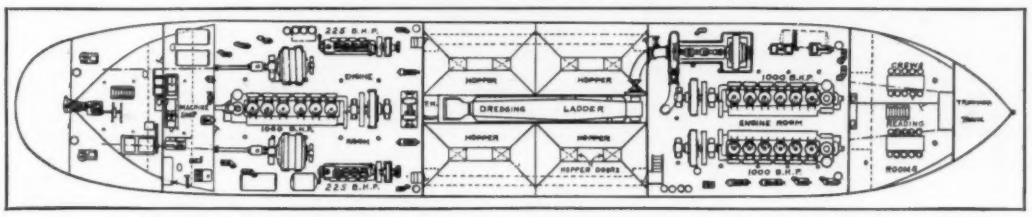
SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, MARCH, 1924

Keeping Open Our Harbor Channels

THAT most efficient body of men known as the Engineering Corps of the United States Army has designed four powerful dredges for maintaining the harbor entrances and channels of the United States, contracts for two of which have already been placed. Particular interest is attached to these ships because they will be driven entirely by electric power, generated in a combination of Diesel engines directly connected to Westinghouse generators. Broadly speaking, they are modeled upon the general lines of the existing steam dredges of the Engineering Corps, but in addition to the electric drive they embody many other improvements looking to high efficiency of operation.

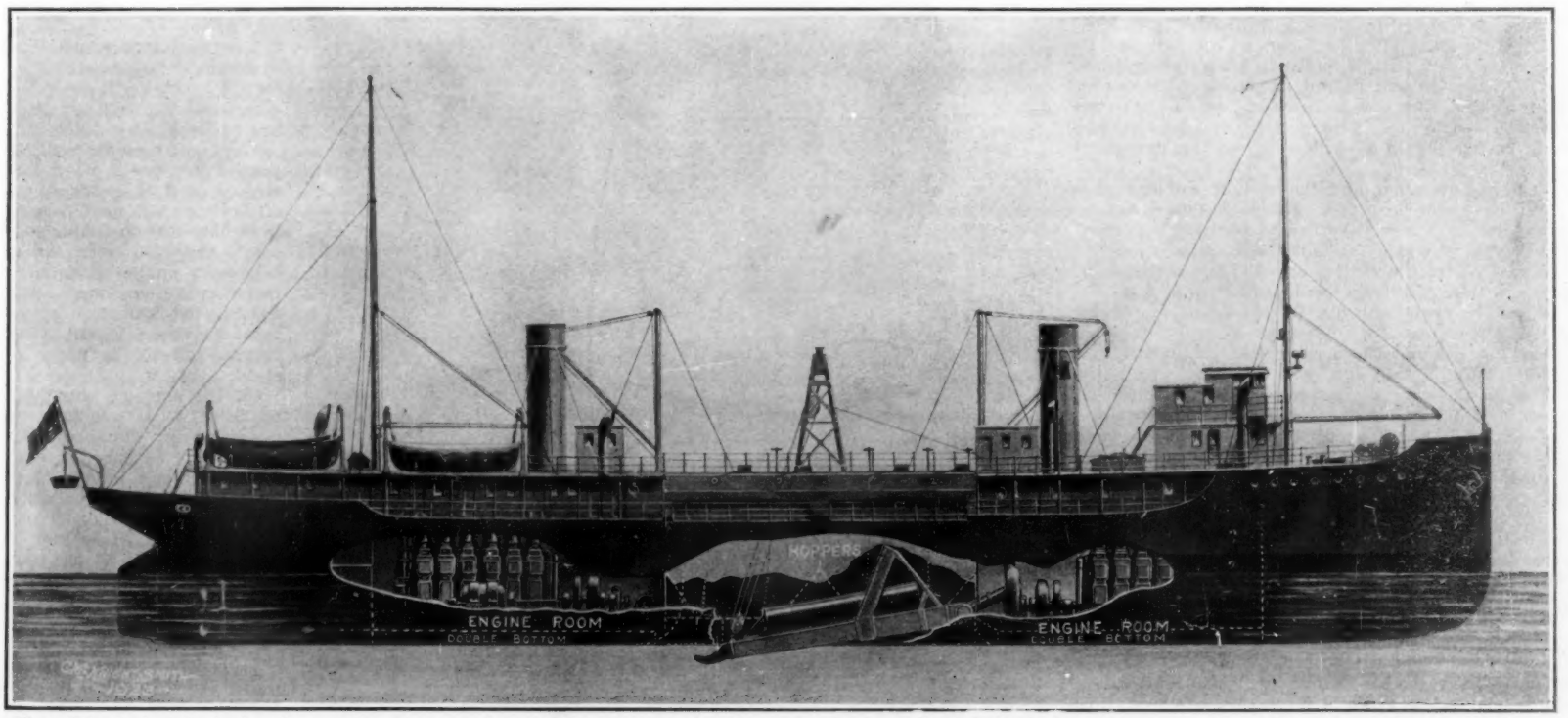


Plan showing arrangement of engine rooms, hoppers and dredging mechanism

Each dredge is 268 feet 5 inches in length over all, its beam is 46 feet and its depth 22 feet 6 inches. Amidships are four large hoppers with a combined capacity of 1250 cubic yards. The hoppers arranged two on each side of a central well, open to the sea, within which is located a 26-inch pipe 45 feet long, which is carried in a frame of steel lattice work. The upper end of the frame is hinged to enable the pipe to be lowered to the river bottom for dredging operations. At its upper end the pipe connects through a flexible joint to the suction end of an 800-horsepower centrifugal pump. At the other or lower end is a heavy steel gridiron which is known technically as the drag. In dredging, the drag is lowered to the bottom of the channel, the pump is started, and the ship is run slowly along the course to be dredged out. The drag, acting like a powerful claw, loosens up the sand or other material, which is sucked up with the water by the pump and discharged into the hoppers. When the bottom is hard, powerful jets of water are discharged against the material, and the rush of water is sufficiently powerful to loosen anything short of rock.

The power plant consists of three 1000-horsepower Diesel engines, each of which is directly connected to a 700-kilowatt Westinghouse generator. There are also several auxiliary generating units. These three engines are located in the engine rooms, one of which is forward of the hoppers and the other aft of them. The current for driving the ship is led to two 800-horsepower Westinghouse motors each of which is direct-connected to its own propeller, and these form the actual propelling machinery of the dredge. The control of these motors is centered in a hand-wheel in the pilot house, so that the navigating officer can control the ship directly without the intervention of the engine-room staff. Electric power is also used for the operation of the powerful suction pumps and for the raising and lowering of the dredging ladder. The vertical movement of the ladder is controlled by cables, which lead to the top of a steel A-frame, mounted astride the well, and down to the lower end of the dredging ladder.

It is doubtful if anywhere else, either afloat or ashore, are so many different applications of electricity to be found grouped together in so small and restricted a space. In addition to driving the propellers the electricity opens and shuts the hopper doors, pumps the supply of water and fuel oil, compresses air for blowing the whistle, makes ice and maintains cold storage, heats and ventilates the ship, warms the fuel oil, runs the machine shop tools, handles the anchors, operates winches and capstans, heats the water, steers the ship, cooks the meals, and—lights the cigars, cigarettes and pipes if you please. On each dredge are 56 electric lights, 100 electric heaters, 25 electric fans, and two electric ranges. Mr. W. H. Easton of the Westinghouse Company is probably correct in stating that these dredges are the first habitation of civilized man where fire in some form or other is not needed. We understand that the United States Engineering Corps will make careful tests of the equipment of these dredges under all conditions of operation, and will publish the results. The work done by the army in establishing and maintaining the harbors of the United States includes deepening Boston from 20 to 40 feet; New York from 19 to 40 feet; Norfolk from 12-19 to 35-40 feet; New Orleans from 9 to 30-35 feet and many other harbors from 8 or 9 to 30-35 feet.



New, Diesel-electric dredge for army engineers. Length, 268 feet 5 inches; beam, 46 feet; depth, 22 feet 6 inches; hopper capacity, 1250 cubic yards. Two of these are being built. They will keep open the channels of our harbors and rivers

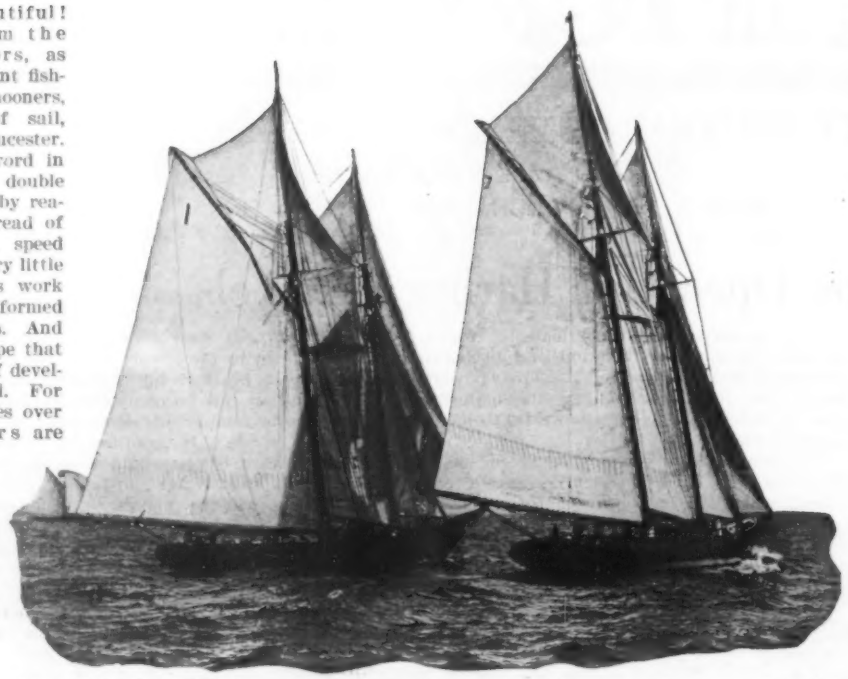
Necessity Mothers the Fisherman

Taking the Smell and the Sails Out of His Daily Routine

By James H. Collins

HOW beautiful! exclaim the spectators, as two gallant fishing schooners, clouds of sail, vie for victory off Gloucester.

They are the last word in fishing vessels in a double sense. The last word by reason of their great spread of canvas, weatherliness, speed and beauty—with a very little white paint and brass work they would be transformed into gentlemen's yachts. And the last word as a type that has reached its limit of development, and is doomed. For no sooner are the races over than both schooners are hauled into dry dock and their engines restored. The beauty that thrilled spectators is the beauty of a dying type, making its last gallant stand against a new and spectacular order of things.



Start of the first official race of fishing schooners off Gloucester—the type of fishing vessel now being transformed into motor ships

Our Atlantic coast fisheries have reached a stage where necessity, the mother of invention, has been called in to save and rehabilitate them.

This was virtually the first American industry. It has furnished fighting men for our navies, seamen for our whalers and clipper merchantmen, pathfinders and discoverers in the world's unexplored regions. For nearly three hundred years it has been conducted with little change in principle, though steady progress in the size of boats, the length of voyages, the improvement of fishing gear and methods. But fishing has become less and less profitable with the development of industries ashore. The hardy New Englanders who sailed out of Gloucester and other shipping ports until fifty years ago found better opportunities in the factories that sprang up in New England, and were also fitted for better-paying work by education in the public schools. They were replaced by the equally hardy "Blue Nose" of Nova Scotia. With the forest on one side and the sea on the other, he was forced to lumbering or fishing for a living, the agricultural resources of his country being meager. But now industry and schools make new opportunities for the Nova Scotian, and he no longer finds fishing profitable—unless it can be put on an entirely new basis.

Fish are abundant and the cost of catching them only a few cents per pound. But even a short distance inland the consumer pays five to ten times as much. Thus, what should be a staple food, is regarded as a luxury. Where the British eat 65 pounds of fish per capita yearly, Americans eat less than 15 pounds.

Worse, by methods of distribution thus far used, fish do not always reach the consumer in prime condition. From the fishing schooner straight through to the peddler with a push cart and tin horn, who hawks fish about the streets, the fisherman has fallen behind other food industries in production and distributing methods, and suffers competition in two ways: First, the competition of more efficiently distributed foods. Second, the competition of other industries that divert man-power.

But now the inventor and research expert are coming to the fisherman's aid. The hard, rough, hazardous work aboard fishing vessels, that keeps men away from home, is being lightened, and fishing trips shortened, by the use of power instead of sail. The motor vessel lands fish more quickly after catching. Instead of being shipped whole, paying freight on waste and ice, the fish are dressed at seaboard, cut into filets or sides, wrapped in vegetable parchment paper, chilled and shipped in various types of insulated containers. Fish are not only brought into the great trend toward sanitary package foods, but into the great distributing organizations that market other foods. Heretofore limited to a few fish dealers and peddlers in the community, now fish can be sold by the grocer and butcher. The offal which was formerly expensive waste can now be turned into oil and fish meal at the seaboard, for soap making, cattle and poultry food, fertilizers and in fact a wide miscellany of other applications.

Fish filets wrapped in sanitary parchment-paper, with shipping case. Package fish of this sort is revolutionizing the industry

Ten or fifteen years ago the fisherman began installing gasoline engines. The industry is conservative, however, and the rising price of gasoline was an adverse factor. Since then, oil engines of Diesel type in sizes as small as five horsepower have been developed, and it is predicted that sail will be a thing of the past in two years. Of 13,000 tons of craft fishing out of Gloucester, 5000 are oil power, 4500 gasoline, 2000 sail, and less than 2000 steam.

With sail, the fisherman spent several days reaching the fishing grounds, and when his catch was complete set out for port, often against head winds. The length of time needed for the return trip was uncertain. It might take a week, and each day's delay had its effect upon the freshness of his catch. With sail, too, he could not leave port without the large crew needed to work the vessel. With motor power, it is possible to run virtually on schedule, making a round trip in three days, a day to go, a day to fish, and a day returning. His catch is fresher, he can make a greater number of trips in the season, and the vessel is easily worked by a small crew when men are scarce.

Thus, the spic and span yacht-like schooner, the fisherman's pride, is being transformed. The sails are furled down to stay until they rot, except for light riding canvas. When they are gone, the booms are taken down, leaving only the masts. The fisherman turns from sailor to mechanic, spends less time afloat and more with his family, and with the wider market and better prices in sight, will find his occupation more nearly on the level of shore industries that have been drawing him away.

Among other inventors, Uncle Sam has made an important betterment through his chemists in the Bureau of Fisheries Department of Commerce. This is a chemical preservative for fishing gear. Nets, seines and traps are both fragile and costly—a very simple looking piece of gear may represent an investment of many thousand dollars. It is subject to salt water, sun, air—most of all, marine growths. From the earliest times fishermen have sought some preservative that would lengthen the life of gear. Tan-bark has been used, and tar. These lengthen the life of gear, but make it heavy, stiff and difficult to handle. Chemists have found what seems to be an ideal preservative in copper oleate, which is now available in a soapy preparation that, with gasoline, makes a solution into which gear is dipped. It adds hardly anything to weight, and does not affect flexibility. While figures are not yet available, it is estimated that copper oleate will lengthen gear life at least 50 per cent, and in some cases double it.

The quality of fish will be greatly improved when inventors perfect artificial refrigeration units small enough to be installed on fishing vessels. Artificial refrigeration is already an important new factor in the handling of fish ashore, but practical apparatus for vessels is still in the future, and ice is used instead.

On the average, only half the fish is food, from 30 to 70 per cent being offal, according to variety. Seventy per cent of flounder goes into the garbage can when the consumer buys the fish whole, 60 per cent of whiting, 55 per cent of cod and haddock, 50 per cent of mackerel. Yet this waste can be turned into by-products that come pretty near paying the fisherman's price for the fish. Until recently, it was not economical to fishermen to turn offal into by-products. The apparatus needed for making fish oil and

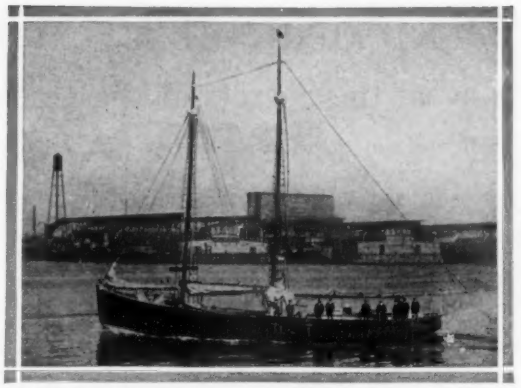
fish meal was obtainable only in large units, and required a considerable investment and a large volume of offal to work on. Now the inventor has come to the fisherman's aid, and units capable of handling waste of a moderate-size fish dealer's business can be secured for less than ten thousand dollars. They are virtually automatic in their operation, cooking the offal, extracting the oil, drying and grinding the meal with only one or two workers.

One of the really magical inventions for the fisherman is a sheet of paper. Under the new way of butchering the fish at the seaboard, utilizing the by-products, different varieties are cut into filets, steaks and boneless sides, and some small varieties like panfish scaled and cleaned ready for cooking. These cuts are wrapped in vegetable parchment paper, put away in a cold room to chill, and then shipped in insulated containers of various types that keep them cool several days. The parchment paper is water-proof and odor-proof. Fresh, well-cleaned fish have little or no odor, but if these filets and steaks did have a "fishy" smell they could be put in the grocer's refrigerator with butter or any other delicate food article. Moreover, the housewife can boil a cod or halibut steak in the paper wrapper which would retain the odor of cooking, and the wrapper prevents loss of moisture or flavor as well.

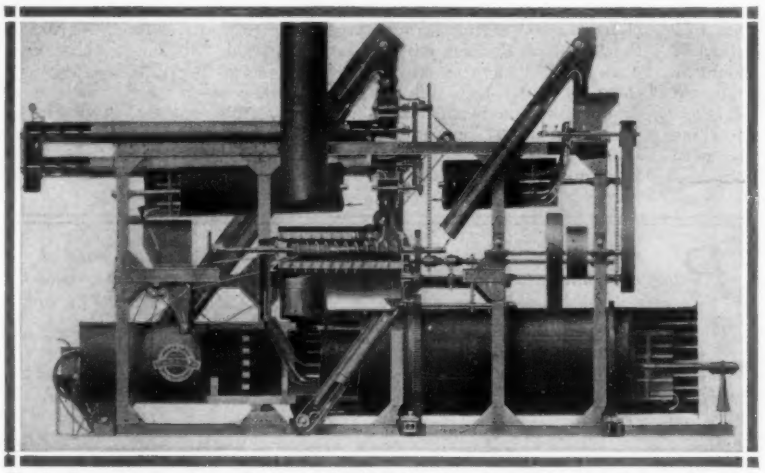
The fish filet has brought a revolution in marketing. It began experimentally in Boston about two years ago. when haddock filets were wrapped in parchment paper and shipped without ice to New England towns during the cold weather. Summer brought the shipment to an end, and they were never made far inland. But one fish dealer's faith in the idea was so strong that he developed a compact box in which a tin container holding the wrapped filet could be shipped with a moderate quantity of ice. A very large part of the difference between seaboard and consumer prices of fish is freight, not on food, but on ice and offal. Success was immediate. Inland grocers and butchers found that people who know ocean fish only by reputation, became customers for these fish filets. Inventive ability has been centered upon shipping-packages of various types, packed to carry fish filets with the minimum amount of ice, and others requiring no ice at all. One notably successful package of the latter type, patented by its inventor, is made of corrugated fiber, and has carried shipments of chilled filets clear across the continent in summer. Besides making fish a package food for the grocer and butcher, shipments are sent regularly to hotels, clubs and institutions. It is estimated that people even within easy shipping distance of the Atlantic seaboard now eat one-quarter as much seafood as they would if it were obtainable regularly at reasonable prices—which gives some idea of the market the filet fish trade has set out to develop.

This package idea is being successfully applied to fish in another way, making it even more staple as a food product for the grocery store and butcher shop. That is, the packing of cooked fish in glass jars, a wonderfully tempting product for the eye when a silvery patterned fish like the mackerel is packed in clear liquor. Glass containers display fish in the show window, so to speak.

Uncle Sam has put his shoulder to the wheel at the marketing end, through the Bureau of Fisheries making surveys of representative cities, securing the names of wholesale and retail dealers, with the kinds of fish each handles, the sources of supply, transportation facilities and rates, the preference by nationalities for particular kinds of fish, and like data. Some of the facts brought to light are startling. Louisville eats only six pounds of fish per capita yearly. Chicago has only 222 exclusive fish dealers, compared with thousands of butchers and grocers, and eats chiefly fresh water fish, more than two-thirds of which come from Canada. Boston has unlimited fish at its front door, yet its fish trade is largely local, Massachusetts alone consuming 56 per cent of Boston's total catch, and only 11 per cent going beyond New York and Pennsylvania. Many inland cities and towns have a prejudice against and even fear of salt water fish, based on indifferent quality under the old methods of shipping whole fish in ice. One promising market suggestion made by the Bureau of Fisheries is that fish be shipped in carload lots, on a regular schedule, dropping off consignments at different towns en route.



A Boston fishing schooner, with motor installed and sails furled to stay down till they rot



Typical apparatus for reducing fish offal to oil and meal, doing the work automatically though on a small scale

A single minor invention shows the inventive "uplift" now going on in the fishermen's business—that of rendering fishing vessels and fish markets odorless. Fresh fish do not smell, but the slime they leave behind in bilge water and on floors and receptacles does—in bilge water it smells villainously. It has been found that these odors can be eliminated by putting electrolytic hypochloride of soda in the bilge water, and using it as a spray or cleansing solution around markets, piers and any other places where fish are handled.

The fisherman is going to college. At the University of Washington, the College of Fisheries has been in operation since 1919, under Dean John N. Cobb, concentrating in Pacific Coast fishing, while in the East research work on fisheries is being carried out at the Massachusetts Institute of Technology. Thus far, the vast amount of scientific work on ocean life has been done by deep sea expeditions, and along zoological lines—very little has been done along the coasts, where the fisheries are, and even less from an industrial and commercial viewpoint.

Besides the inventor, the fisherman needs the help of the capitalist, the salesman and the advertising man. Commercially, the fish trade has been one of small dealers, inadequately organized and financed for distribution, using outworn business methods. Today, new money is coming into the butchering and distribution of fish, new companies are being formed or old ones consolidated, and there is noticeable improvement in business methods. The salesman, given fish in sanitary packages, can extend its distribution to grocers and butchers. The advertising man, through the printed word, can dispel popular prejudice against fish and break down serious handicaps like the consumer habit that leads people to think of it only on Friday.

But the fisherman needs the inventor most of all. From his vessel and his gear, straight through to packages and by-products, there are opportunities for the inventive mind—provided it will tackle the fisherman's peculiar problems after first-hand study.

Some idea of the field for research, invention and promotion is given by Dean Cobb in a summary of possibilities in the fish itself.

A hundred thousand tons of fish offal, such has been thrown away for years, if transformed into oil and scrap, is worth more than five million dollars.

But when fish are butchered like meat animals, there will be even more valuable by-products. To turn all but the edible portions of a fish into oil and scrap indiscriminately is sinful.

As in the packing industry, there are choice tid-bits about fish now going to waste because only a few people living along the seaboard know what dainties they are and how to cook them. To most inland people, the idea of eating fish heads sounds fantastic, though they relish calf's head a la vinaigrette. The meat found on fishes' heads is the choicest of any part of the body, and the cheeks or meaty portions found on the sides of the heads of salmon and halibut, the choicest of all. Cod tongues are another delicacy that now go largely to waste for lack of popular appreciation, and cod sounds still another. The "sound" is the air bladder of a fish, in the cod relatively large; "tongues and sounds" is a constant item in the menu of New England hotels and restaurants.

Fish eggs are another large item of waste in the industry, going into fish meal if they escape the garbage, when they are really a delicacy in themselves if properly cooked, or in some cases can be made into caviar, or canned for use as fish bait.

Likewise, fish yield industrial by-products equivalent to the pepsin and other pharmaceuticals of the meat packing industry. Sounds are used industrially, particularly for the clarifying of various liquids. Another interesting example is the use of fish scales to make an artificial nacre used in making near-pearls. Fish oil is not only a substitute for higher priced oils in certain industries, but when care is taken to make it of sound quality, can be used for edible products after being put through the hydrogenation process. Fish glue and fish leather, too, are capable of development.

The fisherman's vocation has fallen behind in the general progress of the food industries. It now calls for rehabilitation through invention, research, and better business methods. This rehabilitation it is getting.

The chain-store idea applied to the retailing of fish makes an appeal to the consumer quite different from that of the old-fashioned fish peddler

Arctic Exploration by Aircraft

"Shenandoah" to Reveal the Secrets of the Uncharted Polar Seas

By a Member of the Board on Arctic Exploration

THE purpose of naval exploration in the Arctic is to determine and chart the location of land in an area one-third the size of the United States. This 1,000,000 square miles lying between Alaska and the North Pole is as yet unexplored. A single dash into such an area determines little. To know the area requires search and mapping by aerial photography in a systematic way. The work of the first summer could accomplish reconnaissance, the possible general location of some land, the proof of the feasibility of charting by the dirigible "Shenandoah" and by planes equipped for work on ice and water, and the establishment of bases with dirigible mooring masts from which the whole work could be continued in the future. If any land is located or if the charting proves that land does not exist then the United States has added that much to the scientific knowledge of the world.

Imaginative people who are not interested in this dull charting of islands say the United States may, through this work, be the first to establish an air route from Western Europe to Japan over the top of the world. An island here and there as a possible landing place is of more interest to those of a practical turn of mind. This short cut from London to Tokio would be made by flying from Spitzbergen to Nome, Alaska, via the Pole. The distance between the last two places is about 2200 nautical miles. The cruising radius of the "Shenandoah" at fifty knots is 3000 nautical miles with an additional margin of 15 per cent. The real business of exploring and charting the region north of Alaska has confronted aviation with problems that are forcing design forward with great strides. Short of actual war there has been nothing that has acted as more of a prod to designers and operators than the order of the Secretary of the Navy to do this work by aircraft.

Both planes and the dirigible "Shenandoah" are necessary for this work. The "Shenandoah" is used chiefly because of her greater cruising radius, but she has added advantages in ability to carry considerable photographic equipment, scientific instruments, and ability to hover over a spot to take observations of the sun for fixing locations of places on the earth's surface. The planes are of use for shorter flights in the neighborhood of the northern operating base. These planes can secure aerological data that can be sent by radio to the United States to acquaint the dirigible as to weather conditions. After the northern base has been established with a mooring mast for the dirigible, the "Shenandoah" could fly by stages from Lakehurst, N. J., to the Alaskan base.

In the selection of a northern base the vicinity of Nome, Alaska, offers the best site to an American expedition. This is because of its early accessibility by steamship, the ice breaking up off Nome in the first week of June. It is near the unexplored area and at the same time within easy reach by radio of United States bases; it has some local facilities for landing the materials of masts and other equipment, and it is in United States territory. Points in Greenland and Spitzbergen are much nearer the Pole than Nome, but since one summer month will be spent in establishing a base only two months of summer are left—July and August. Two ships are being equipped with mooring masts, one to be stationed at Nome, the other at Spitzbergen. At Nome the mean temperature over a number of years has been June 45 degrees Fahrenheit, July 51 degrees Fahrenheit, August 50 degrees Fahrenheit. All things considered the vicinity of Nome is the best location. Nome is 1500 nautical miles from the Pole.

The exploration of the whole area this distance would dictate a more northern base. Pt. Barrow, the most northern point of Alaska, is 1100 nautical miles from the Pole but the ice conditions prevent its being reached until the first of August, and then only by small vessels especially constructed for withstanding the force of ice jam and working through the broken ice. At Pt. Barrow there is no certainty of landing the structure materials and fuel for a complete base in a single season. This is because there is clear water off Pt. Barrow only for two to three weeks and in some seasons it has been known to last only for six hours. At Pt. Barrow the mean temperatures over a number of years have been June 35 degrees Fahrenheit, July 41 degrees Fahrenheit, August 39 degrees Fahrenheit. It might be advisable to cache gasoline here for refuelling. Two hundred people could hold the "Shenandoah" in a calm while this was done. If a mooring mast could be erected here in one season it would be of great use in succeeding seasons for securing the "Shenandoah" for refuelling. The problem of transporting 60 tons of mooring mast and of taking gasoline and workmen to Pt. Barrow is involved in this.

As the "Shenandoah" in crossing high mountains gets into rarer atmosphere the helium in the large gas cells of the bag expands and would rupture the cells if helium were not let out or "valved." This means a loss of helium, which is very valuable. This loss can be prevented in ordinary operation where the heights encountered are considerably less than those of the northern Rockies. If previous to the flight the greatest elevation to be met is known, then the "Shenandoah" starts with cells partially filled with helium so that they will expand to about 100 per cent capacity on reaching the highest point, but will not expand to a point where valving is necessary. However, to cross the 8000-foot Rockies enroute to Seattle, the "Shenandoah" would have to start with gas cells 23 per cent short of full. But this presents another interesting problem in the performance of the dirigible, namely, that with only 77 per cent of gas in the bag there is not sufficient lift remaining to buoy up all the gasoline that is required for fuel on the trip from Lakehurst to Seattle. All of this can be obviated by crossing the Rockies in the South where they are lower, *i. e.*, by flying from Lakehurst to Fort Worth, Texas, 1191 nautical miles; from Fort Worth to San Diego, 1003 nautical miles; from San Diego to Puget Sound via the coast, 1150 nautical miles.

The use of gasoline fuel during the long flights necessary for exploring lightens the ship considerably. This means that she is too buoyant and would rise to altitudes not desirable, and that to come down helium would have to be "valved," to make her less buoyant. This did not worry the Germans on the short flights from Germany to England; but both the Germans and English have given considerable thought to this problem of becoming lighter as fuel is consumed. On the long flights to be made on this expedition this is serious and is being cared for in a most interesting way. A means has been found for recovering enough water from the gasoline burned to make up for the loss of weight in gasoline. This water recovery is possible because when gasoline burns, one of the products of combustion is hydrogen which, when combined with the oxygen of the air, gives water sufficient to replace the weight of gasoline lost as fuel. With ability to manufacture water ballast on board, the valving of the precious helium in descending is avoided.

Although the winds for July and August average seven miles per hour at the Nome base, the "Shenandoah" must be prepared for occasional gales that blow here as high as 60 miles per hour during these months. To be able to meet adverse winds with a good margin of fuel is the chief reason for reducing the length of flights considerably below her full cruising radius in calm weather. When free in the air she can safely ride out a gale but must have sufficient excess of gasoline to permit her to do this and then tie up at the end of the storm and refuel.

A mooring mast for the "Shenandoah" built on a ship would serve to advance the base at Nome by the amount the ship is able to proceed to the northward from Nome as the ice clears. A ship large enough for this is not small enough to work through the ice as the wooden sealers and whalers do, but must wait for comparatively clear water. This ship with a mooring mast, in addition to reducing the length of trips of the "Shenandoah" by two or three hundred miles, also may prove valuable in being able to seek a lee where the wind is much less than at the permanent Nome mast.

Another ship fitted with a mooring mast and stationed at Spitzbergen would act as a still further aid in shortening the radius required of the "Shenandoah," for suppose that on exploration work in the neighborhood of the North Pole, adverse winds are encountered on the return to Nome (1560 nautical miles from the Pole), then the "Shenandoah" could continue on to Spitzbergen which is only 640 nautical miles from the Pole. Spitzbergen was selected as a base for dirigibles by Count Zeppelin as early as 1910. He went there with Prince Henry of Prussia and a staff of scientists and selected a low open valley as an admirable site for an airship base for North Polar work. The Germans kept a party on aerological work there until 1914.

For all this long distance work the "Shenandoah" must have good communication by radio. The demand has already been put upon radio engineers to double the radio transmitting distance from the "Shenandoah," thus improving the ship's usefulness both as a naval scout over long sea reaches and improving one of her commercial needs. In addition she will be equipped with radio compass for taking bearings on radio transmitting stations in America and Europe and thus assist the navigators in locating her position in the polar region.

POLAR exploration via the air, barring the premature enterprise of the unfortunate Andree, is a totally uncharted field, and those who enter it must make their own rules. What these rules are to be in the present aerial attacks upon the pole is indicated, so far as is possible in advance, in the long and the short articles on this page. Attention is also called to the discussion on page 154, in which a member of the Naval War College gives us some indication of what the explorers hope to find.
—THE EDITOR.

Amundsen's Flight to the Pole

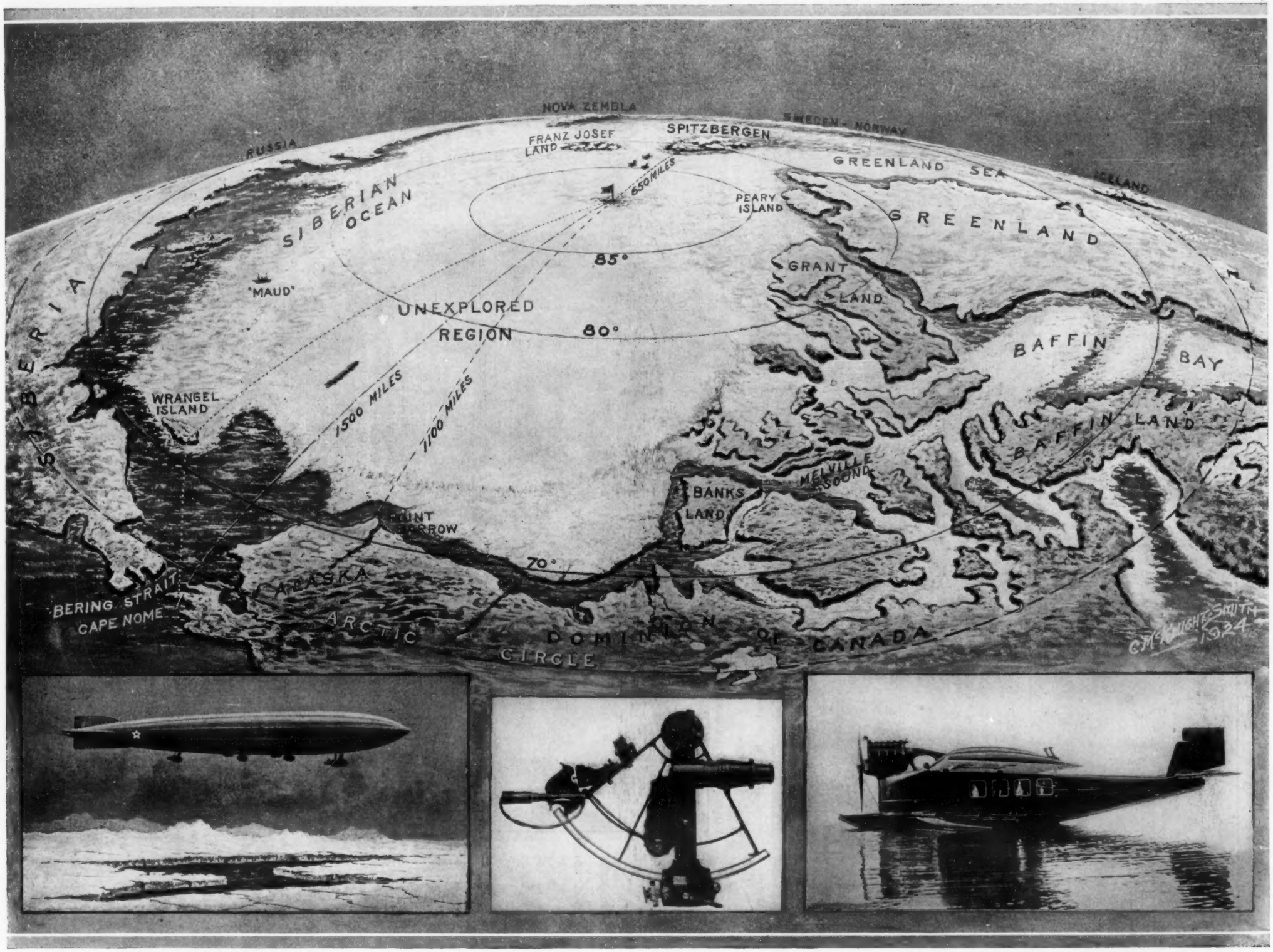
THE activities of the Navy Department in Polar exploration will not be confined next summer to its own work by means of the "Shenandoah." According to an announcement made last year by Secretary Denby, Lieutenant Davison of the Navy will command one of the three seaplanes with which the Amundsen expedition will make the attempt to reach the Pole and ultimately cross over to Alaska itself.

A non-stop flight across the Arctic regions is not in contemplation. The distance from Spitzbergen to Alaska is about 1750 miles, and it is intended to make the flight in relays. The first step will take place early next summer, when the planes will be carried by ship to the edge of the ice pack; which, it is expected, will be found at a distance of about 450 miles from the North Pole. From this point flights will be made to the Pole, where there will be established a depot of supplies of food and fuel. For this bold undertaking Amundsen has chosen the Dornier Dolphin flying boat which has been so built that it can take off with equal facility from ice, snow, or water, and, of course, make corresponding landings. Each seaplane will carry radio of sufficient range to enable it to keep in communication with the depot ship.

The Dornier machines are monoplanes of the all-metal type. At the bottom of the plane is a member which is designed for taking off or landing under difficult conditions. It is actually a small wing, so shaped as to afford a certain amount of lift. Its under surface is strongly ribbed to enable it to ride without damage over the rough surface of the ice. The body of the plane is commodious and it provides warm, enclosed cabins which are as completely appointed and as comfortable as the cabin of a small yacht.

The squadron of three planes will be manned by six men, one of the planes being under the immediate command of Captain Amundsen. Judged from the naval standpoint, the navigation on such a flight as this will be of particular interest; for in the Arctic region lying adjacent to the Pole, the magnetic compass will be practically useless and all courses will have to be laid by the sun. The 24 hours of daylight will be favorable to this; but on the other hand there will be a disadvantage to radio communication.

Of great help to the explorers will be the double sextant which is used in the United States Navy for the navigation of airplanes. This instrument eliminates the necessity for a horizon in making observations of the heavenly bodies. Probably it will be used in place of the artificial or mercurial horizon.



The "Shenandoah" over the ice fields

Double sextant for Arctic navigation

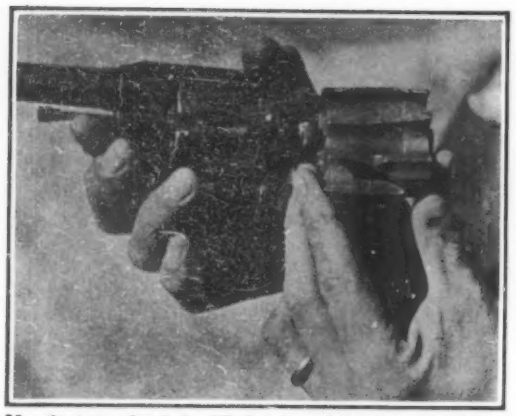
Three of these roomy planes will be used by Amundsen

MAP SHOWING THE UNKNOWN REGIONS OF THE POLE WHICH THE NAVY WILL EXPLORE WITH THE "SHENANDOAH" NEXT SUMMER

Gun Catastrophes

Some of the Reasons Why Small Arms Open Up at Points Where They Were Not Intended to Open

By Capt. Edward C. Crossman



No factory load is likely to mistreat a revolver thusly; a break of this sort is the result of a powder overload, and is usually from reloaded ammunition

ACCORDING to figures compiled by the Government there are some seven million hunters in these United States, and each year some small proportion of the said seven million turn up at the gun sellers' mart with a tale of woe which would move even a police court judge to tears. The tale invariably is one in which the gun used by the huntsman proceeded to shed its component parts or develop unusual openings in the barrel in a fashion totally reprehensible, not to say low-down, and entirely uncontemplated by the manufacturer thereof.

Few people with any considerable experience in the use of firearms have missed that pleasing and interesting sight of a gun suddenly erupting in a spot where no eruption was planned in its original design. The performance is not surprising in view of the many grades of guns for sale, the many sorts of people using them, the high internal pressures of even the small and inoffensive .22 caliber, and the unfortunately hasty and irascible disposition of a charge in the barrel when some obstacle is placed in its way.

Without exception, in the tale told by the shooter, the fault lies in the gun or the ammunition, or both. Cold analysis of cause and effect, and reproduction of the wreck by the means suspected, develops that the tale usually lacks sadly in accuracy, in fact is about 99 per cent shy thereof. Because while it is human to err, and gun and ammunition plants are run by human beings, however the shooter may doubt the fact at times, the factories are systematized and possessed of vast experience, neither of which can be said of the merry hunters who sally afield each season.

About 90 per cent of the blown up guns may be laid at the door of the shooter—due to his sins of commission or omission. If he was using reloaded or home-loaded ammunition at the time of the unfortunate incident, a prima facie case is established against him. It may not be a conclusive one, and he may prove an alibi, but most of the time ammunition grown in the old home garden and used in a gun which ceases to be useful as a gun, is at the bottom of the trouble.

Shotguns and pistols pretty well divide the field of firearms catastrophes between them, the rifle bringing up a bad third in the hard-luck race. This is true largely because the shotgun has comparatively thin tubes, and because it is so often used under conditions which encourage getting the bore plugged with mud or snow. Likewise is the unfortunate fact that two sorts of propellants are used in shotgun ammunition, one a powder practically fool-proof because of the space it occupies, and known as "bulk;" the other using up very little room for equivalent charges and hence, if loaded by an ignorant loader in a "bulk" measure, or through the semi-occasional mistake of a factory, resulting in a generosity of charge which proceeds to take the gun barrel apart.

Revolvers and pistols are unfortunate in that their ammunition is very touchy in loading and in later storage. The quantity of powder used is so small—from two grains weight, upward—that a fine chance offers itself for more than one load in a cartridge or no load at all, in the very rapid automatic loading machines. The very light, feathery grains of much of this dense pistol powder are prone to stick in the measure because their weight is not enough to overcome the friction or cohesion of their little paper-thin grains.

Also, queerly enough, the bullet, which after leaving the muzzle is powerful enough to drill through a man, has so little spare energy that it sticks in the bore of the pistol with little provocation. This is particularly likely to occur with metal-jacketed bullets, with their very high friction against the bore walls. I have often seen bullets from the well known and standard .32 automatic pistol cartridge, when fired in an "adapter" in a .30 caliber rifle barrel of practically the same bore size, take two seconds for the trip of the bore, and strike the ground a few feet from the rifle, proving that the friction of the bullet nearly offset the thrust of the powder gases. This is marked when the rifle has been fired previously with the service charge, and left uncleaned, with the sticky residue in the bore.

With the automatic pistol the charge insufficient to drive the bullet out of the bore is also insufficient to function the mechanism, and the attention of the shooter is usually invited to the irregularity by the fact that the gun did not reload itself. With the revolver no such warning is given, unless the shooter senses the reduced recoil, and a second chamber, fired without noticing anything wrong with the first, will infallibly produce a ruined gun through the presence of the first bullet sticking in the bore.

Pistol cartridges, habitually left in the gun, are sensitive to the presence of oil or cleaning fluid which is also often found in the chamber or cylinder of the revolver. Some oils and some cleaning fluids are so subtile that they will leak in past the primer or past the bullet and spoil the powder or primer. Smokeless powder is very sensitive to oil or grease.

The result of such leakage, common enough to impel one large factory to produce a special line of oil-proof revolver and pistol cartridges, is either a misfire or a weak combustion of the powder sufficient perhaps to move the bullet up into the barrel of the gun, but not out of it.

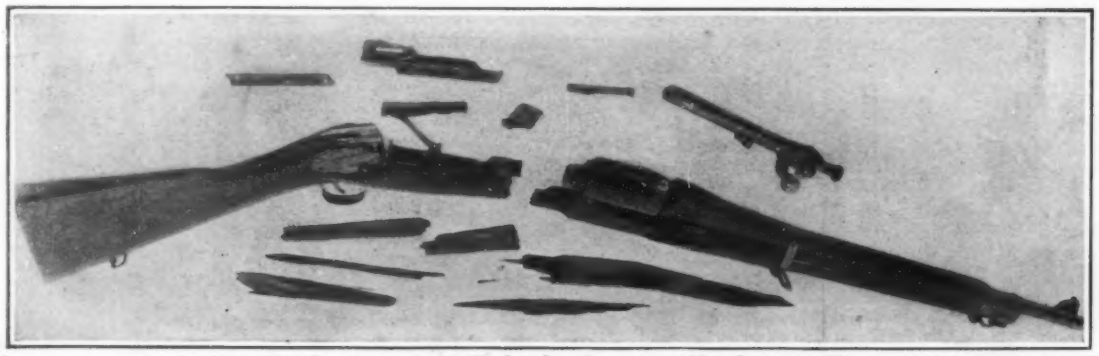
Pistol ammunition left in storage in a high temperature, such as might easily be developed close to a steam radiator or a chimney, is sufficiently reduced in power to cause bullets to stick in the bore of a pistol. While visiting a Government arsenal during my duty as an army officer, tests were made in my presence with ammunition for the service caliber .45 automatic pistol, which was exposed to a temperature of 150 degrees Fahrenheit for 12 hours, and then fired through the chronograph. Five makes of ammunition were tested. One gave normal results; one showed a loss of 50 feet in range out of the original 800 feet; two others showed a loss of 150 feet; and of the fifth, four shots stuck in the bore of the pistol, while the other six, though leaving the muzzle, failed to reach the other end of the short chronograph range. Of the ten shots made with one of the brands that dropped 150 feet off their range under these conditions, two also stuck in the bore. With the automatic, as pointed out, this would not function the mechanism of the gun, as a rule; but if the slide were hauled back by an excited man, and the gun fired with a normal charge, it would infallibly burst the barrel or bulge it enough to lock the gun against functioning.

These troubles, however, almost invariably result in wrecked barrels, and possibly the slide encircling them in the case of automatic pistol. When the factory or gun merchant is presented with the spectacle of a revolver with three chambers blown into one and giving the general appearance of a house with the front wall removed and two or three floors left exposed to the public gaze, then he can usually inquire into the sort of charges the owner used in his reloading; for this sort of wreck is not often seen except when hand-made ammunition is used, and the happy ammunition expert gets two or three charges of powder into one case, as is easily done through the superabundance of room therein.

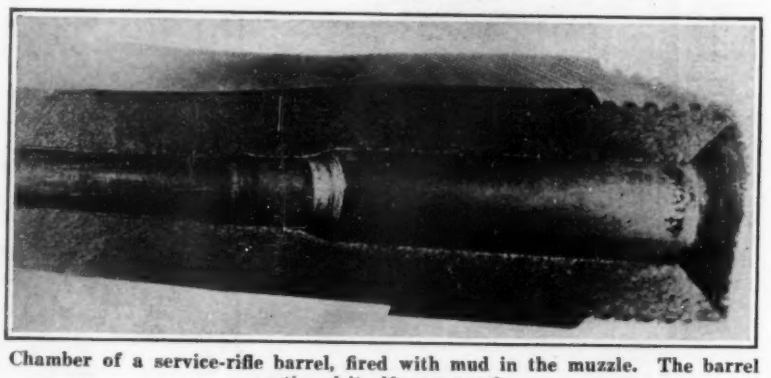
Most shotgun troubles arise from obstructions in the bore, and the cause is easily diagnosed from the location of the burst. Overloads of powder invariably blow out a section of the chamber lying over the case or immediately forward of it at the "cone" or reduction of chamber diameter to barrel diameter. The gentleman attempting to blame the ammunition for a handsome rent in his gun barrel a foot from the chamber, is trying to make a 10 per cent grade with only 10 pounds of steam. Faulty ammunition does not so perform. Most shotgun shooters know this, and their plaint with a burst barrel is that the material was defective or there was not enough of it for safety.

While it is true that faulty stock gets into a barrel now and then, through a seam or burned spot in the original forging, and while a double-gun factory has been known to strike a barrel down to a paper thinness, still the odds are ten to one that this is not the cause when a barrel develops a large and deckle-edge rent where the gun had no rent before.

The belief used to be common that sealing the bore of a firearm would then and there, on discharge, result in the exit of the charge from an extemporaneous opening in the barrel created just short of the seal.



A government Springfield rifle that blew up in the hands of a navy rifle shooter. The ammunition was tested; cause of accident unknown



Chamber of a service-rifle barrel, fired with mud in the muzzle. The barrel sectioned itself very neatly

Experiments, both of my own and of gun factories and arsenals, fail to agree in results with this theory, with all due respect for its advanced age and its grey hairs. Grey hairs, of course, occur at times even on a donkey. Likewise does the ancient theory, once vigorously upheld, that a burst in a gun barrel from an obstruction is caused by the compression of the air, fail to check up with the results of experiments.

Experiment proves that to burst or bulge a gun barrel an obstruction heavy enough or sticky enough to cause a perceptible check to the charge, must be used. Sealing of the bore, that is, preventing the free escape of the air pushed ahead of the charge, is not at all essential in the wrecking of a gun barrel. The bore may be sealed freely provided the means used for said sealing, such as thin paper tied over the muzzle, is not sufficient obstacle to check the charge.

When the obstruction is sufficient to check the progress of the bullet or load of shot, a certain wave action is set up in the powder gases following behind, giving enormous increase in the pressures, and sometimes, but not always, bursting or bulging the walls of the barrel.

An old superstition held that the suction of the gun bore of the shotgun was sufficient to draw the basewad from the case and suck it up the bore a certain distance until friction overcame the decreasing drag of the suction. Then upon the next shot the basewad would trip up the charge, and burst the gun barrel. So firmly is this believed that one ammunition company announces that its basewads are locked too tightly to permit of this happening.

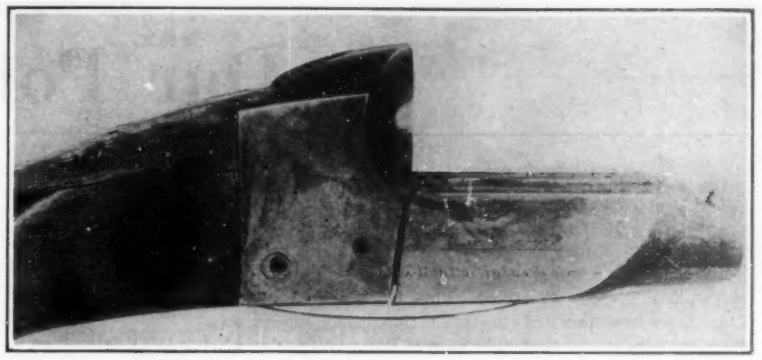
So far as I know the theory has never been proved, either that the basewad is drawn up the bore of the gun or that it would then burst the gun on the next shot. Deliberate experiments, placing wads at various spots in the bore of the gun, proved that they were not sufficient to burst ordinary barrels.

What will burst a barrel with beautiful certainty and promptness is the shot charge and wads which might be blown up into the bore by a charge of powder insufficient to move them clear out of the gun. About two grains of bulk powder is sufficient to give this pleasing effect, which might come about through the bungling loading of the amateur cartridge maker, or the faulty machine in a factory, such a measure running empty.

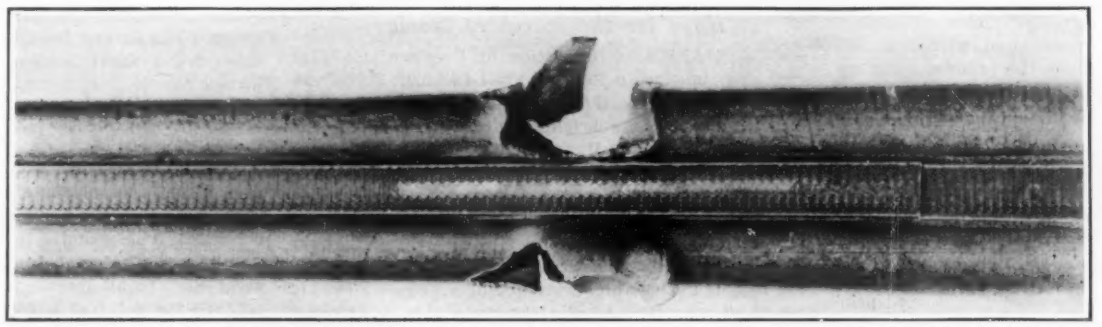
The paper-thin walls of a shotgun barrel, burst by an obstruction in the bore

Unless the shooter is very excited, the lack of recoil and noise would notify him that nothing much had taken place within the chamber of his gun at the faulty shot, but he might easily mistake it for merely a misfire, eject the case, and fire another shot with the previous charge lodged somewhere in the bore.

It is a highly pious idea for the gunner, finding anything out of the ordinary in his shot, to stop and investigate fully. What seemed merely a misfire might easily be a partial movement of the charge or bullet through the bore of the gun, and a lodgment therein, with the certain results of a wrecked barrel the next shot, if not a mangled hand in the case of the shotgun or rifle. The shooter has no business firing another shot after an apparent misfire without carefully inspecting the cartridge or the bore, to make sure that nothing undue transpired, and this should be invariable, regardless of how plentifully the birds or burglars may be flushing in front of him, or how badly he wants to plug the next shot right away, without delay.



This is the weak point of the shotgun frame. Firing both barrels at once, or an overloaded cartridge, will sometimes break it here



The right barrel of this double, hammerless shotgun burst in the hands of the owner. The burst in the left barrel was produced in the factory, by dropping in a 20-gage shell and then firing a 12-gage shell behind it. Not much question what burst the right barrel?

Rarely does a high-power rifle develop trouble more than a bulged or burst barrel, and not often the latter. The cause is almost always an obstruction which has fallen into the barrel, or been left in during the cleaning process. Once in a blue moon a bullet sheds its jacket and leaves it in the bore, to produce a bulged barrel the next shot. This is a rare case, but anything unusual in the shot, a failure in the bullet to register or its very wild impact should be cause for seeing that "the hole goes clear through" the barrel, before again firing.

Our service rifle has a distressing habit, now and then, of utterly wrecking its receiver, from the junction with the bore clear back to the tang of the arm. Sometimes the cause is hard to diagnose, but primarily it is due to the faulty design of all bolt action or other type of rifles using rimless cartridges. The bolt cannot, in the nature of the case, entirely support it around its head, and weak brass or undue chamber pressures rupture the case around the head, let out the gas at its playful pressure of 50,000 pounds per square inch, when normal, and wreck the receiver at its junction with the barrel.

This, of course, releases the bolt and generally takes apart the entire mechanism of the rifle, as shown by the illustration of one I recently examined. Queerly enough the shooter is rarely injured with all the frightful scatteration of good strong steel parts close to his face. This is a semi-rare happening, as proved by the ratio of about one blow-up to a couple of million shots fired, but when it does occur it is very disturbing to the man who does much shooting with the military rifle.

The chamber pressure of the humble .22 short, beloved of the shooting gallery, is about 10,000 pounds per square inch of chamber area—four tons. The chamber pressure of the shotgun runs from 6500 to 11,000 pounds per square inch, or around three to five tons. The chamber pressure of the various rifles ranges from the short figure of 10,000 pounds to the 50,000 pounds or 25 tons, of the service rifle.

If the shooter will keep in mind the fact that he is handling an engine of tremendous internal pressure and power, and not a cane or an axe or an alpenstock, then will those miscreants, the gun and ammunition makers, be found to be quite human in their ambitions, and to be making ammunition and guns far more reliable than dreamed of in the philosophy of the shooter.

Darwin and Evolution

IN an address before the American Association for the Advancement of Science at its Los Angeles meeting in September, 1924, Dr. David Starr Jordan said:

"Nothing we know takes place without an adequate cause. Among the attempts to search for causes for phenomena in animal and plant life, the most notable have been those of Lamarck and Darwin. Lamarck noted the facts of use and disuse in the development and modification of the individual, and suggested that the higher groups must have originated in like fashion. Hence the theory of development through the inheritance of acquired characters, hereditary traits being modified from generation to generation through use and disuse of organs or other causes.

"Darwin went much further, stressing especially the sifting and splitting due to varying environment. These he summed up under the complex term of 'Natural Selection.' He conceived of a 'struggle for existence' with the continued survival of those which could maintain themselves, bequeathing their adaptive characters to their progeny.

"There is a recent tendency among biologists to ignore Darwin and his method of approach in favor of more metaphysical conceptions of evolution, as unconditioned by environment. The process of induction is slow and laborious, that of deduction may be speeded up as demanded. The basal fact remains, the method of Darwin of considering all relevant truths is the only way. The causes are the matters really important."

After emphasizing that the descent of living forms from series now extinct is too obvious for any well-informed mind to question, Dr. Jordan continued: "We would like to know how this came about. Darwin's work is like a great sketch map which his successors are filling in and in no vital respect will the final chart vary from the ascribed landmarks. Naturalists have found that they can produce in a few weeks by selection and segregation forms apparently as distinct as Nature can establish through similar means in a millennium. But Nature's species are of long endurance and the reason why this is so is a vital problem.

"We know nothing of evolution in vacuo, of change in life unrelated to environment. All forms of life are split up into species with adaptation to external conditions visible in every structure. We know of no way in which organisms become adapted to special conditions except by the progressive failures of those which do not fit. No organism can escape this process.

"To admit these facts and yet say that selection and segregation are not factors in evolution would appear to make the matter a mere question of words. If by evolution we mean the theoretical progress of life, due solely to forces intrinsic in organisms, then outside influences are of course not factors in such evolution. If, however, we mean the actual movements of actual organisms, on this actual earth, then intrinsic influences and obstacles are obviously factors."

Our Point of View

A Senatorial Inquisition

IF THE possession of a supreme sense of proportion is the outstanding mark of a man of genius, it must be admitted that the recent investigation of the Bok Peace Award by the Senate can scarcely be called a stroke of genius. Indeed we are inclined to think that their amazing procedure indicates that this august body has entirely lost, at least for the time being, its sense of humor. Certainly it has lost the sense of the proper scope and limitation of its own prerogatives.

Here is the case of a United States citizen, widely respected and beloved, who, in the endeavor to promote the cause of peace, offers a prize for the best essay on the subject. Nothing wrong, surely, in that. The winning essay out of the twenty-two thousand sent in is selected, published, and widely distributed. So far, so good. When certain of our Senators come to read the essay, they find in it a more or less complete endorsement of that, to them, most accursed document, the League of Nations; and forthwith, having constituted a committee, these gentlemen proceed to let forth a howl of rage, punctuated with innuendo and vituperation, through which the practised ear can detect a strong undertone of political apprehension. Well, there is nothing wrong in that. Politically considered, that sort of thing, we suppose, is "perfectly all right."

But when the Senate proceeded to call Mr. Bok before its committee and demand that he tell them why he offered this prize and what he spent upon the effort, they were no longer perfectly all right but perfectly all wrong. There are among the prized possessions of the people of the United States some most sacred principles known as "the sovereignity of the people," "the freedom of the press," "and the freedom of speech," and this high-handed inquisition of the Senate is a direct and most impertinent attack upon these inalienable rights of the American people.

The SCIENTIFIC AMERICAN is not a political journal. We can express no opinion for or against the League of Nations or any similar question; but when we see such an audacious interference with the fundamental rights of the individual citizen, we raise our voice in protest. The prestige of the Senate does not stand at such a high level, just now, that it can afford to make so amazing an exhibition of itself as it has done in this recent inquiry. We like to hold our Congress in high regard; and it positively hurts our feelings to see the smile of amused contempt which the mere mention of this incident seems everywhere to beget.

To the members of the committee who have thus and at last achieved a surely secure immortality, we commend some simple lines of a simple Scotch laddie:

"O wad some Pow'r the giftie gie us
To see oursels as ithers see us."

Tremendous!

THERE is fashion in words, as in clothes. Someone or some group of men begin to favor a particular word, or it is used in connection with a crisis that attracts nation-wide attention. Usually it is a sonorous word, and if, as in the present case, it carries a sense of the dramatic, so much the better; for it is then well launched on the wave of popularity. Not so long ago "absolutely" had its run. Where the simple "yes" would have served, the interrogee would say "absolu-u-u-tely." That lute-like third syllable would be held, lingeringly, on the lips, and with evident relish.

Not long ago we drew attention to the vogue which the word "tremendous" was having, and we mildly suggested that it was being tied up with words for which it made but a sorry mate. The fashion is still with us. Writers of all kinds and degrees seem to feel that if an article is not freely sprinkled with "tremendous," it will be wanting in "pep."

Now please listen to this. Recently, during our editorial browsing, we came across a technical article, compact, well expressed and informing, in which the author used the word "tremendous" no less than nine times. He spoke of a "tremendous saving of time"; a "tremendous capital investment"; a "tremendous complexity"; "tremendously high speeds"; "tremendous power"; "tremendous concentration of power"; "tremendous difference in results"; and, ye Gods! "tremendous refinement!"

Now one "tremendous," or two at the outside, should satisfy the requirements of an article of two thousand words or so. But surely the author is not so tremendously full of inspiration that he must use nine tremendous relief valves to let it all out.

Let him therefore write of a *great* saving of time, a *large* capital investment, and a *troublesome* complexity. Let him describe the *intense* concentration of power, the truly *tremendous* power which makes possible such extraordinarily high speeds.

Thereby and with patience he may arrive at an *extreme* refinement of his literary style.

Hope for the Merchant Marine

THANKS to the action of President Coolidge in placing Rear-Admiral Leigh C. Palmer in charge of the Emergency Fleet Corporation, there is a brighter future in store for the American Merchant Marine. The President has removed the actual operation of the ships from the politicians and placed it in the hands of a practical and very able "sailorman." The significance of the term "sailorman" will be understood when we say that, in the Navy, to call an officer "a real sailorman" is to put the last, if not the highest, mark of approval upon his qualifications. The Admiral knows a ship from truck to keelson, and if he is left alone, the vessels of the emergency fleet will be run as they should be. The applicant for position will not be asked "what are your politics," or "what is your religious faith;" he will not even be asked whether, in the late war, he would as soon have fought against the British as against the Germans.

So far, then, as Leigh C. Palmer is concerned, our costly wartime fleet will be efficiently maintained and operated; but we repeat, this will happen only if the Admiral is "let alone." But who is to interfere with him? Unfortunately the Shipping Board is in the position to do so. If Mr. Coolidge could have had his way, Admiral Palmer would have had a free hand. Evidently the President would have liked to wash out the Shipping Board, or at least place it under this naval officer and give him a free hand in salvaging our fleet and running it on practical lines. Unfortunately, legislation will be needed to abolish the Shipping Board.

So here we have a practical, high-class, naval officer subject to a political board, whose record is one of incompetence and extravagance, and whose policy of repudiating commercial treaties would render hostile every maritime nation in the world and besmirch the good name and high faith of the United States. The new head of the Emergency Fleet Corporation should be given a free hand. The best way to ensure this is to abolish the Shipping Board altogether.

The Way of a Ship in the Air

A CURIOUS instance of the persistence of habits of thought and point of view was shown in the press descriptions of the so-called "fight" of the "Shenandoah" with the furious storm of wind and rain which tore her loose from her moorings. As a matter of fact, when she broke away, the storm, for her, was over. Like a free balloon, she moved with the moving air. Looking at the airman from the ground, it is difficult to realize that, for him, the hurricane that makes us bend over and brace ourselves to avoid being swept away, simply does not exist. The airman knows no hurricane other than that of his own making. The "Shenandoah" with her engines dead was in dead air. With all engines open she could produce, relatively to herself, a windstorm of 65 miles per hour. Had she driven herself before that 70-mile gale or against it, there would have been not one iota of difference in the stresses to which she would have been exposed.

The writer had an interesting talk with an officer who was in the pilot house when the ship broke loose. He spoke of the loud din made by the flapping of the fabric covering of the ship and the "groaning" of her basket-like metallic framework. It sounded alarming at the height of the storm, but it held no threat of danger to the structure of the ship as a whole. He was making some notes on the chart table, when suddenly the racket ceased. All became still. Immediately he knew that she was free from the mast; or to put it in the language of the sea, "her moorings had parted." That sudden silence—no flapping of canvas—no creaking of straining joints—no roar of the gale—tells the story. So far as "Shenandoah" was concerned, since she was amply furnished with water ballast and gas-venting valves, and had several thousand miles of fuel capacity in her tanks, the trouble was over.

Captain Heinen told the writer that, once they had dropped ballast and brought the ship up, he found the rest of the night voyage "very interesting and enjoyable."

Approaching Deadlock in Street Traffic

TRAFFIC on the streets of New York is steadily approaching a density which will involve an absolute deadlock. That is to say, the time occupied in waiting for this line or that line of traffic to get permission to move on will be so great that, to all intents and purposes, we shall have reached the point of positive stagnation.

Should the contending voices, each clamoring for the construction of its own ill-digested scheme of rapid transit, agree tomorrow upon a unified plan, and should construction be begun at once, with all the energy of the city behind it, street traffic conditions will have reached the point of deadlock before such plans can be carried to completion.

By far the most important question among the many which make up the problem of getting the ever-increasing millions of people to and from that great workshop which is known as Manhattan Island, is that of connecting the Island with the outlying suburban districts. How shall the crossing of the Hudson River be done? There are two proposals under discussion; one of which would solve the problem by building several tunnels, the other by erecting a single bridge. The latest announcement states that by the time the present vehicular tunnel under the Hudson, with its terminals, plazas, and street approaches, has been completed and opened for service, it will have cost $45,000,000. For this great outlay it will provide in the two tubes for only four lines of traffic. Four such tunnels would provide 16 lines of traffic for a total cost of $180,000,000.

On the other hand, the proposed Hudson River bridge at 57th Street, which also will cost $180,000,000, will provide on its upper and lower decks for more than twice that number of lines of traffic, including motor traffic and rapid transit trains, and in addition it will provide wide pathways for foot passengers. It has been claimed that a bridge of this large capacity would produce great local congestion at its approaches. This is not the case; for the latest plans provide for the construction of a six-track elevated automobile and motor car roadway, extending from the entrance of the Hudson River bridge to the entrance of the bridge over the East River at 59th Street.

So excellent is the organization for bridge building, both at the fabricating shops and at the bridge itself, that a bridge even of this magnitude could be completed in five years from the day on which ground was first broken. The tunnels would have to be built successively, and it would be at least ten years before the whole four of them could be completed. Tunnel building is too slow a process; it can never catch up with the city's growth.

Here and There

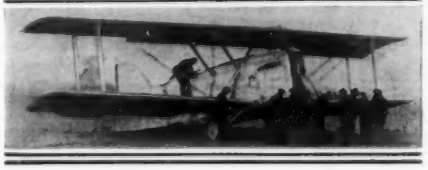
NO introduction of the name of Madame Curie need be made to our readers. One of the interesting scientific events of recent weeks occurred on the twenty-fifth anniversary of the discovery with which this celebrated name is connected. The occasion was dignified by the payment to Madame Curie, in the presence of President Millerand, of the first installment of a pension voted her by the French legislature in recognition of her scientific achievements. In this connection it is interesting to quote the modest title under which her discovery was announced to the Academy on December 26, 1898: "A note, by Monsieur and Madame P. Curie and Monsieur G. Bemont, upon a new radioactive substance found in pitchblende." This substance, of course, was radium. Our photograph shows Madame Curie in the working garb of her laboratory.

THE thing that we call "sound" is simply vibrations—waves in the air, or in some more solid substance. When these waves fall upon the human ear, they give rise to the sensation of sound—with one proviso. The ear is sensitive only to vibrations within a certain range. The faster they come, the higher the "pitch" of the sound; the slower they come, the lower. But the ear has a lower limit and an upper limit. If the waves come too slow, or too fast—if the pitch is too low or too high—the ear does not respond to them, and we hear nothing.

Now nature in general suffers no such limitation as this. Every day, in thousands of ways, things happen—the movement of insect wings, for instance—which give forth vibrations of far too great frequency to be audible to the human ear. Similarly, in the growth of plants and in numerous other instances, we have phenomena giving off vibrations that are too slow to make an audible noise. We should like enormously to hear these vibrations, for they are just as interesting as the ones that come within our range.

We can't hope to hear them directly, but Dr. Phillips Thomas, research engineer of the Westinghouse Company, pictured herewith has now made it possible for us to see them, giving us a means for direct observation of many phenomena which have heretofore been quite hidden from our senses. His device consists simply of a ring containing two electrodes, between which plays a glow discharge produced by high voltage. This discharge will respond, in visible fashion, to air vibrations pitched all the way up to a million cycles per second, where the human ear stops at an upper limit of 20,000 per second. Nobody knows just what will be discovered with the new instrument, but it is sure to have broad results. One of the first suggestions is that it will enable the entomologist to observe the methods by which insects communicate with one another—there seems little question that this communication is through "sound" waves that have been inaudible to us on account of their very high pitch.

THERE is fair chance that during this year a flight around the world will be accomplished either by our British friends or ourselves. Aside from the usual question of national pride, it matters little: the successful accomplishment of this feat is rather for the good of aeronautics. What a gruelling test for an airplane! Somewhere between 25,000 and 35,000 miles of travel; facing all kinds of flying conditions; far from machine shops and replacements, so that the fliers will have to depend on themselves, to a great extent; flights over wide expanses of open sea. It will require a sturdy plane and a sturdy engine and a sturdy crew. Little wonder, therefore, that such a rugged craft as the Douglas Wright biplane, shown in the accompanying view, is being considered as compared with the frail biplanes of not so long ago.



WHILE photographing the bombardment of atoms by electrons in his laboratory, Professor William D. Harkins of the University of Chicago, whose portrait adjoins these remarks, recently observed an entirely new type of ray. It appears to be a light-wave, presumably of a heretofore unknown wave-length; and to be given off by minute particles of matter. The discoverer has given it the name Zeta ray; and he suspects that it may turn out to have some relation with the problem of getting useful force out of the disintegration of the atom. First announcement of the discovery was made at the recent meeting of the American Association for the Advancement of Science, and was regarded as one of the more important developments of this meeting.

NEWS dispatches of recent date remind us again of the potentialities for destruction lurking in the most innocuous-appearing species of dust. Any finely comminuted matter whatever, it appears, is likely to produce a violent explosion, given the appropriate conditions. This time the apparently innocent substance that dealt out death to some two-score people was ordinary starch; and this produced enough dust to explode, in spite of the fact that it had a moisture content of 12 per cent. It will perhaps surprise some of our readers to learn that this is a well recognized hazard; that the accidental production of a spark in an atmosphere moderately laden with dust of any sort is likely to lead to an explosion quite as severe as that of January in Pekin, Ill.

ACCORDING to Dr. Francis C. Wood, Director of the Crocker Institute of Cancer Research of Columbia University, a marked advance in the treatment of this dreaded disease has been made possible by a new type of X-ray tube. The new tube has a higher emissive power—that is to say, it is as though the candlepower of an ordinary lamp had been increased six-fold. In addition, it is designed for use with higher voltages than have been practicable in Roentgenology. The result is to reduce the necessary exposure from two or three hours per patient to twenty minutes, and to increase the life of the tubes. Incidentally, the new tube gives a greater proportion of rays of the type that cure certain forms of cancer, and less of the sort that attack healthy tissue. Dr. C. T. Ulrey of the Westinghouse Company is the inventor of the new tube. The inventor and his scientific infant are portrayed at the right.

UNDER the most unfavorable conditions, it begins to appear, radio reception is possible, or at least may be hoped for with some degree of confidence. Only a few weeks ago, for instance, in spite of the enormous masses of grounded steel in the Woolworth Building, a very small and low-powered set, self-contained, with loop in place of antennae and with no ground at all, functioned fairly well at a demonstration in this office. A day or two later, tests were made to determine whether the radio could be used for the purpose of communicating, to men working under ground, warning of danger in time to enable their escape. The experiments were carried out in the Hudson Tunnel, joining New York and Jersey City. In spite of the fact that the receiving apparatus was under 80 feet of steel, concrete, mud and water, the programs of the local broadcasting stations were heard with complete success.

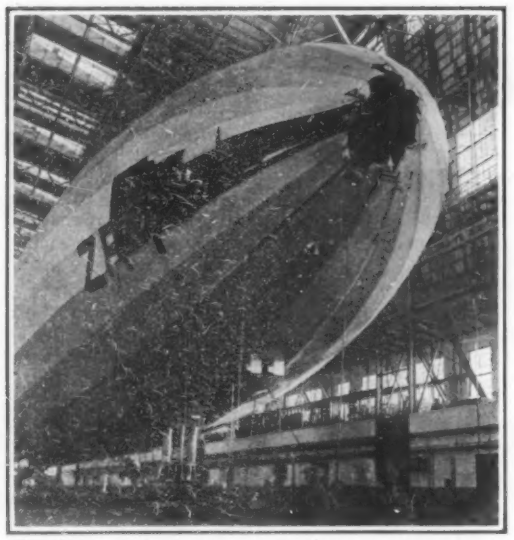
DISMANTLING of the Tutankhamen tomb, with the view of removal and reerection on another site, proceeds, but under difficulties. The work is necessarily slow, since elaborate scaffolding must be erected in a very confined space, and the job has therefore to be taken in very small bites, or the scaffolding of one part would interfere with the work on another section. Also, it is found that some of the tongue-and-groove construction of 3200 years ago was not put up with any idea that it should ever be possible to take it apart without damage; and the effort to do this has, in more than one place, come perilously close to defeat. This is indeed an engineering problem of considerable novelty; the wrecker of buildings ordinarily works with the primary object of getting the structure down, and when in the past he has had to preserve it intact, it has usually been a small affair like a historic log-cabin, or a monolith like the obelisks from Egypt that now stand in London and in New York. The Carnarvon-Carter expedition is actually making engineering advance as well as adding to our archaeological knowledge!

THERE is something in an organism which determines the location and arrangement of parts—for example, a head at one end, that tentacles shall arise in a circle around the body, that right and left sides shall be alike. But from time to time something goes wrong with the machinery of this adjustment, and the human or some other animal gives birth to monstrosities and malformations. Progress toward the discovery of the specific causes of such accidents was indicated by Dr. C. M. Child, Professor of Zoology at the University of Chicago, in a paper read in Cincinnati recently. Dr. Child told of experiments indicating that variation in the electrical and chemical conditions at different points of the embryo are responsible for the normal divergent lines of development of the various organs, and that alteration of these conditions from the normal is responsible for malformations.

PROLONGED study of the boll weevil by the United States Bureau of Entomology has led to the conclusion that the freshly hatched insects make their way to the cotton field by means of an extraordinarily acute sense of smell. It is inferred that they are attracted by an odor peculiar to the cotton plants, and experiments are under way to determine whether this odor cannot be done away with, or imitated in such fashion that the weevils may be lured into traps. The reactions of the insect to the odors of peppermint, wintergreen, honey, citronella and other pungent substances have been tested, and the Federal scientists hold out hope of being able to build up a sort of siren's song of odors that shall carry deception to the olfactory organs of the weevils. Incidentally, the weevil keeps right on spreading; the only visible result of twenty years' work has been to slow down its expansion. Increasing every year, the boll weevil affords graphic evidence that the balance between insects and humans is a delicate one, and that a very little thing might exterminate us in their favor.

A Wild Night on the "Shenandoah"

Blown from Her Mooring-Mast, the Ship Weathers the Storm and Is Brought Back to Port



The ship was torn loose from the mast by a heavy gust on the starboard bow. The two forward bags lost their gas

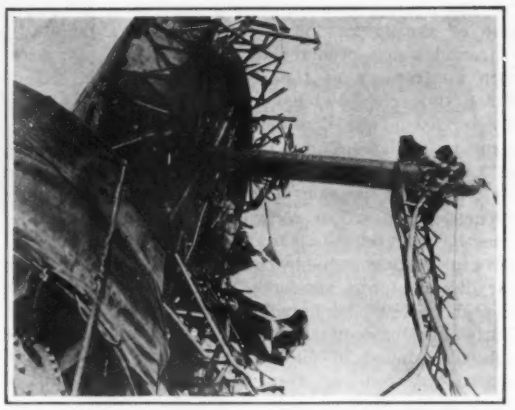
ON THE early evening of January 16 and at the close of a four-day test, the "Shenandoah" was torn from her mooring mast by a gale of cyclonic strength, precisely at the moment when the anemometer at Lakehurst Station registered a wind velocity of over 75 miles. She left her cap on the mast and disappeared in the gloom with a gaping hole in her bow. During the early part of the storm the ship rode comfortably to the mast and no difficulty was found by the quartermaster in keeping her head-on to the wind; but the whirling gust which tore her loose evidently had veered several degrees, probably fifteen or more, to starboard, and the greater area presented to the wind coupled with the fact that the pull was no longer in the line of the ship's axis but considerably to starboard, brought an extremely heavy tensile strain on the lee side, at the point of attachment of the longitudinal girders to the nose-cap. They parted, and the rupture became progressive until the cap was torn entirely out of the ship.

Our photograph of the "Shenandoah" shows that the pull on the cap was to starboard; for as the ship was swept from the mast a long strip of the outer cover was ripped from the starboard side. Moreover, the mass of the frame wreckage is to starboard. In some way or other, as the wreckage was torn loose, the two forward gasbags were ripped and deflated. This loss of buoyancy caused the bow to sink, and it was only the quick action of the officers and crew in discharging the forward water ballast, and, a minute later, in dropping two of the forward fuel tanks through the canvas bottom of the ship, that brought the bow up and saved it from crashing against the forest trees as she passed out of the flying field. Later in the flight one other tank was dropped.

Thanks to the discipline of the engine-room force, the engines were started at once and successively, so as to give the ship steerage way and check her speed before the storm. By the time she reached Newark, the wind was beginning to moderate, and swinging around over Staten Island and towards the coast, she ultimately began to work her way back to the hangar, where she was safely brought down and housed before daybreak. The control of the ship was greatly hampered, it should be noted, by the fact that the diagonal gust of wind which tore her loose wrecked the upper stabilizing fin and threw the adjoining rudder post out of line.

The good ship throughout that wild night was in command of Lt. Commdr. M. R. Pierce and Chief Engineer Lt. Commdr. J. M. Deem; and fortunately Captain Heinen was aboard and was able to draw upon his own long experience of 15 years as pilot. But the reporters of the daily press, urged on by the demand that there be plenty of "human interest" (which often is only another name for sheer sensationalism) in their work, spread abroad a weird story of disorganization and clash of authority between the officers in charge and the said Captain Heinen. That there was excitement goes without saying, for the crisis was sudden and great; but Captain Heinen was too well versed in the discipline of the sea and the air, not to know that he was aboard in a consultative capacity only. It is needless to say that, because of his long experience, he was invaluable in the emergency.

The public has been given the impression that the actual peril to the "Shenandoah" came when she broke adrift. This is not so. Except for the sinking of her bow, which was quickly remedied, she was under much less stress after she broke free than she was at her mooring. Before that she was a rigid object in a great stream of wind that was rushing by her at 60 to 70 miles an hour. As soon as she broke loose, she began to float with the wind and quickly assumed the same velocity. When that condition was reached, there was but little more wind strain upon the ship than if she were floating on a breathless summer day above her flying field. So accustomed are we dwellers upon *terra firma* to refer everything to mother earth, that the average layman finds it difficult to realize that, once an airship is free of the ground, there is for him no longer any wind velocity. Hence, through all the long and stormy night which seemed so terrific to us, the "Shenandoah" was floating quietly, unbuffeted and unstressed and, except for her damaged bow and stern, was able to turn herself to her home port as easily as though there were a dead calm.



This umbrella-like structure is the nose-cap, which was torn out of the ship and left hanging from the masthead

The difficulty of navigation came from that badly torn bow and still more from the completely wrecked upper fin and the bent rudder post. It is greatly to the credit of her navigating officers that she was able to work her way home to a safe landing without tearing off more of her canvas covering and wrecking some more of the exposed forward gas bags.

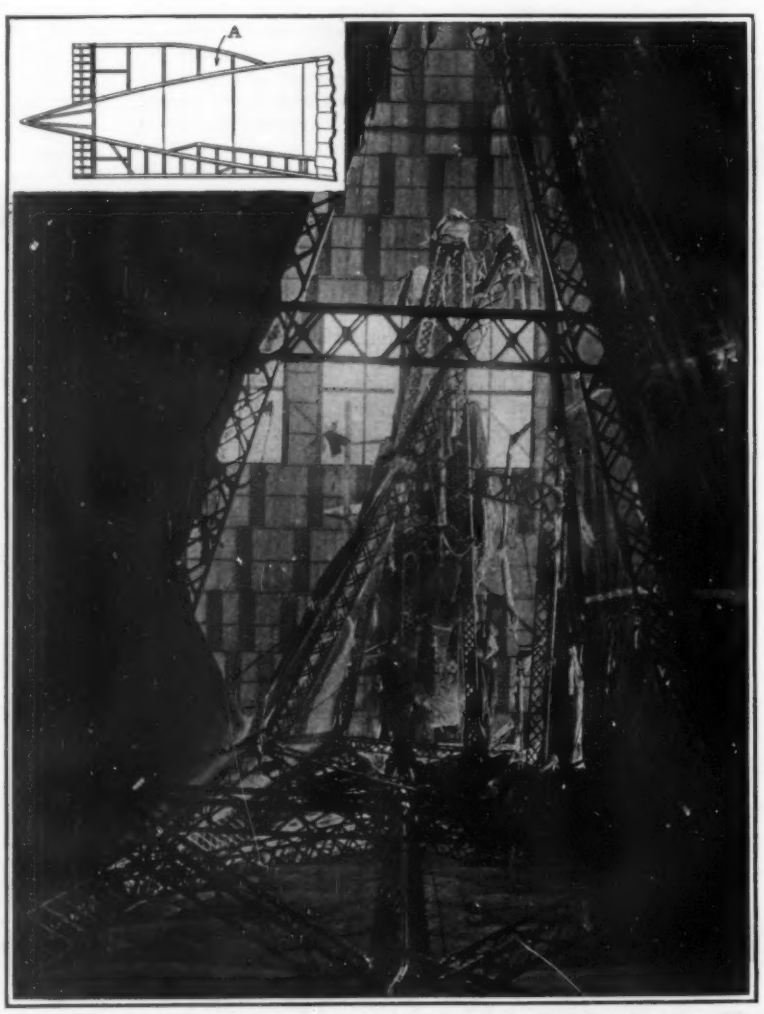
Let it be clearly understood that both the mooring-mast and the ship came bravely through the ordeal. The mast, which is an extremely strong and stiff structure, stood up to its work. The tearing away of the nose-cap does not by any means prove that no airship can ride out a storm, even of cyclonic strength, at her mooring. On the contrary, we believe that by distributing the stresses evenly over a larger area of the bow of the ship it would be possible to hold her intact, even when she is struck such a sidewise "swipe" as tore the "Shenandoah" loose.

Perhaps the most interesting of our pictures is the view taken from within the forward portion of the upper stabilizing fin, looking aft towards the vertical rudder post. It certainly shows a very sorry wreck and demonstrates the dynamic force with which the cyclonic gust struck the ship throughout its whole length from bow to stern.

The fin that was wrecked consists of a series of A-frames, the tallest 25 feet in height, built upon the extreme end of the ship. They are tied together and kept in place longitudinally by the ship's structure below, and above by a longitudinal girder extending from apex to apex until it reaches the vertical rudder post astern.

Because of its height and comparatively narrow base, the fin structure has always been more or less of a constructional problem. It was difficult to hold it in line, and the Germans gave a good deal of thought to the design. As can be seen from the photograph the dimensions are large, and it proved difficult to hold such a big surface rigidly above the narrow and comparatively frail base. Although the fin is sufficiently strong while it is being drawn parallel with the air stream, manifestly it is not well adapted to withstand a side blow such as tore it apart in the recent gale. It will be noted that, yielding to the pressure, two of the A-frames were pushed over to the port side, one of them being broken apart at its apex. They are carried upon shallow, double A-frames built upon the circular frames of the ship, and in each case the port leg of the upper A-frames crushed in the structure below. The top longitudinal, as the fin was bent out of line,

(*Continued on page 207*)



This view was taken within the wrecked fin at point A, looking aft. The heavy quartering gust that tore the "Shenandoah" from the mast struck the fin, canted the frames to port and ripped away the fabric

Our Abrams Investigation—VI

A Study of the Late Dr. Albert Abrams of San Francisco and His Work

By Austin C. Lescarboura

Secretary to the SCIENTIFIC AMERICAN Abrams Investigation Committee

DR. ALBERT ABRAMS is dead. He passed away suddenly on Sunday, January 18, from an attack of pneumonia, on the very eve of his scheduled appearance as the star witness in the trial at Jonesboro, Ark., of Dr. Mary Lecoque, an E. R. A. practitioner charged with using the mails to defraud. The Government alleged that the Abrams practitioner in this case diagnosed the blood of a chicken as that of a human, and offered a cure after the specimen had been sent her through the mail. This trial was one of several disagreeable events confronting Dr. Abrams, and no doubt weighed heavily on his already over-taxed mind and health.

It is fitting at this time that our investigation be directed towards a study of Dr. Albert Abrams who, after all is said and done, was the mainspring of the entire E. R. A. technique. To this day the basic facts of E. R. A. remain unproved, so far as the scientific world is concerned; and those who have accepted the E. R. A. technique have done so largely on their faith in Dr. Abrams. Indeed, in our constant and unrelenting efforts to obtain some evidence of the basic phenomenon on which this entire structure of queer ideas and still queerer practice rests, we have always been referred to Dr. Abrams. Individual E. R. A. practitioners, despite their every-day use of this method in making diagnoses and giving treatments to their patients, have declined to submit themselves to our tests but have preferred to have us deal directly with Dr. Abrams. Then, when we have tried in every possible way to make some kind of test with Dr. Abrams which would immediately prove or fail to prove his basic claims, we have found Dr. Abrams quite unprepared and obviously unwilling to aid us in our sincere quest except under his own, unscientific conditions.

Let us study the late Dr. Albert Abrams, not only as an individual, but more particularly as the foundation of the E. R. A. idea. If anything he was E. R. A. personified; and one begins to wonder whether this technique can be as effective now that Dr. Abrams is gone. However, that remains to be seen.

According to "Who's Who," the clipping from which is herewith reproduced, Dr. Albert Abrams was no ordinary man. His degrees were extensive and he was quite proud of them. His letter-head and his literature never failed to give all his degrees and titles, and in this, as well as in many other ways, he went pretty far astray in the matter of professional ethics, particularly those of the medical profession. That he was an indefatigable worker, we cannot deny. He wrote many books. His record shows a constant striving for something new. He took a keen interest in X-rays when Roentgen's discovery was announced, just as he took a keen interest in the electronic theory. He became interested in chiropractic, osteopathy, and other kinds of therapeutics, aside from the orthodox medicine in which he received his original training and experience. In fact, this fascination for something new and his inventive type of mind caused him to develop various techniques culminating in the Electronic Reactions of Abrams. It is not strange, then, that for greater freedom of action he resigned from the orthodox medical fraternity.

Boston[illegible] Com., Dec. 19, 1916—. *Home:* 12 Marbie St. *Office:* 11 Appleton St., Boston.

ABRAMS, Albert, physician; *b.* at San Francisco, Dec. 8, 1863; *s.* Marcus and Rachel (Leavey) A.; M.D., U. of Heidelberg, 1882; A.M., Portland U., 1892 (LL.D.); post-graduate courses, London, Berlin, Vienna, Paris; *m.* Jeanne Roth, of San Francisco, Nov. 25, 1897; 2d, Blanche Schwabacher, Sept 28, 1915. Prof. pathology, Cooper Medical Coll., 1893-8; pres. Emanuel Polyclinic since 1904. Fellow Royal Micros. Soc.; mem. San Francisco Medico-Chirurg. Soc. (pres., 1893). Cal. State Med. Soc. (v.p., 1889.) *Author:* Synopsis of Morbid Renal Secretions, 1892; Manual of Clinical Diagnosis, 1894; Consumption—Its Causes and Prevention, 1895; Transactions of Antiseptic Club, 1896; Scattered Leaves of a Physician's Diary, 1900, Diseases of Heart, 1901; Nervous Breakdown, 1901; Hygiene, in A System of Physiologic Therapeutics, 1901; The Blues, 1904; Diseases of the Lungs, 1905; Self-Poisoning; Diagnostic-Therapeutics, 1909; Spinal Therapeutics, 1909; New Concepts in Diagnosis and Treatment; Spondylotherapy, in Reference Handbook Medical Sciences, 1917. Founder of spondylotherapy and hon. pres. Am. Assn. for the Study of Spondylotherapy; pres. Am. Soc. for Psycho-Physical Research; discoverer Abram's Reflexes and Electronic Reactions of Abrams. *Clubs:* Authors (London); Argonaut (San Francisco). *Home:* 2151 Sacramento St., San Francisco, Calif.

ABRAMS, LeRoy, botanist; *b.* Sheffield, Ia., Oct. 1, 1874; *s.* James DeWitt and Almina Bar-[illegible] A.; student [illegible]

Clipping from "Who's Who," giving the brief life history of Dr. Abrams

Such an active man as Dr. Abrams was bound to be well known in medical circles long before he became famous through his electronic reactions. As far back as 1887 he was professor of pathology at the Cooper Medical College. He was connected with the Emmanuel Polyclinic and other institutions, and as a practicing physician in San Francisco he enjoyed a wide clientele. His diagnostic skill was often sought by other physicians and particularly surgeons, even when he was still using more or less orthodox methods. His writings attracted a good deal of attention on the part of doctors, and no little controversy. But it was not until Abrams announced his discovery of the electronic reactions and their applicability to diagnosis and treatment that he became a great influence in medical circles. He surrounded himself with several thousand practitioners who took up the E. R. A. technique, and these practitioners, in turn, converted tens of thousands of laymen to this new idea. And all the while the basic phenomenon has never been established in a scientific way, despite the bald fact that E. R. A. claims run counter to our present-day knowledge of physics.

The late Dr. Albert Abrams of San Francisco, originator of the E. R. A. technique

That, briefly, is the really wonderful feature of E. R. A. It claims to do remarkable things as a matter of every-day routine. The E. R. A. practitioner, to all appearances, is enabled to diagnose the state of health of any individual from the blood specimen of that individual, or even from the handwriting. He can determine not only the present diseases and ailments, but also those diseases and ailments which may develop in the future, and which are now present in the incipent stage and impossible of detection through orthodox methods, even including pathological examinations and X-ray explorations. He can, if he is as competent as Dr. Abrams was, determine the religion of the individual from the blood specimen. He should be able to locate the individual at any given moment. He should be able to tell the nationality of the individual and many other pertinent facts, always from the drop of blood or the handwriting alone. But—should a scientific body such as our investigation committee endeavor to make a simple test which would prove once and for all the basic truth of this bizarre procedure, we are immediately informed, much to our surprise that such a request is unreasonable. We are asking too much! Even Dr. Abrams expressed his surprise at such a request.

So the wonderful feature of E. R. A. is that it has been accepted without any proof whatsoever of its basic truth. Of course, E. R. A. men will hasten to deny this allegation, but our answer to them is that we are prepared to retract this or any other statement we have made at any time after they have come forward and proved to us that we are misinformed. By proof, obviously, we mean real proof. A simple test means more in the way of proof than hour after hour of mere vaporings, and page after page of meaningless correspondence. Already we have had too much of this kind of cooperation from them and too little of the real and serious cooperation which we had every reason to expect from them, if they were sincerely anxious to establish their case before the world.

All of which is by way of showing how Dr. Abrams, single-handed, was able to gather about him several thousand doctors and near-doctors; how he was able to attract to his own clinic, and to the offices of E. R. A. men, tens of thousand of everyday people seeking relief from their ailments; how he was able, in the eyes of a large number of people, to discredit established medical science; how, in view of the mysterious workings of his ridiculously crude apparatus coupled with the human reagent, he was able to make us wonder whether, after all, our great scientists like Millikan, Einstein, Edison and others really did know what they were talking about; how he was able to work up his followers to practically a religious fervor, in which state they do not hesitate to curse anyone who does not immediately fall in line with their own beliefs. All this he did, and more too, without being obliged to give the world any real proof. Truth to tell, he *could not* and *knew he could not* give the world a clean-cut scientific demonstration. He admitted as much to those whose names, through their unbounded enthusiasm and strong endorsement, were closely linked up to his.

It may be, although it now seems rather doubtful, that Dr. Abrams did come across some mysterious characteristic of the human body, and that, in a crude, blundering sort of way due to insufficient scientific knowledge and training and lack of precision apparatus, he was unable to master what he had discovered. Such a statement on our part is most charitable; but then our entire attitude has been highly charitable. We have continued this investigation long beyond the point justified by the plain facts in the case. Other investigators long ago would have rendered an adverse opinion based on the ridiculous claims made for this technique, the total lack of proof, and the refusal of E. R. A. to submit their claims to fair tests. But we have been fretful lest after all, somehow, somewhere, there be something basically true and wonderful in this Abrams mystery, and that by rendering an adverse opinion we might be robbing the world of something vitally important. Furthermore, we have kept and we continue to keep in touch with E. R. A. men and their work so that there may be no repudiation of our final findings, on the grounds that we did not give them sufficient time to prove their case. Our decision *must be* and *will be* final.

And the foregoing explains why we have been so lenient. We have overlooked many things—superficial things of no real scientific significance. Unlike other investigators, we have not been influenced by the ethics of certain E. R. A. practitioners. We have not been influenced by numerous E. R. A. failures and individual exposés. We have not been influenced by the unfavorable legislative measures which are threatening to terminate E. R. A. practice in various States. We have not been influenced by the reports of the American Medical Association, for they are obviously an interested and biased party. We have not been influenced by the contracts and the rental rates and other commercial aspects connected with the leasing of the Abrams apparatus to individual practitioners. We have not been influenced one bit by the general, unsatisfactory aspect of the entire matter from an investigational standpoint. Instead, we have gone right ahead, keeping in touch with various E. R. A. men, with Dr. Abrams, with certain so-called electronic societies, and with several individuals who claim to be engaged in serious research work for the purpose of extricating the basic discovery of Dr. Abrams from its awful entanglement of handicaps and placing it on a firm and reputable and

(*Continued on page 207*)

"Thirty Years of Psychic Research"

Richet's Monumental Compilation, and Schrenck Notzing's Story of His Work with Eva

Reviewed by J. Malcolm Bird

SELDOM, in the presence of a book to be reviewed, have we suffered so keenly the feeling of inadequacy as at this moment, while fingering the keys of our machine in search of a good jumping-off place from which to introduce our readers to Richet's "Thirty Years of Psychical Research." Never have we found it so wholly the case that the only adequate review would be to present the author's entire text. No series of quotations of Richet's high spots, no selection of passages for endorsement or controversion, be they ever so skillfully strung upon the thread of editorial comment, would do this volume justice. We shall therefore forego this traditional technique of the reviewer, and so far as is possible in the space available, we shall try to give a concrete idea of the contents of the book.

Richet has been for many years the senior member of the Department of Physiology at the University of Paris. His repute in the field of psychic research is no less than in that of orthodox science. Obviously he brings to psychic research an unusual knowledge of the normal possibilities of the human mechanism. What he now attempts, with signal success, is to give us a text book of psychic science. "I have confined myself," he tells us, "to a statement of facts and discussion of their actuality, not only without advancing any theory, but scarcely mentioning theories; for all theories yet proposed to account for these facts seem to me terribly frail." This aim he executes with great skill, and without giving the book any of those formidable aspects or those possibilities of tedium which the use of the term "text book" might imply. In one respect, however, he does not live up to his promise to keep off the grass of theory. He does not advance any theory of his own, to be sure; but he does, at every opportunity, make faces at the spirit hypothesis. This he regards as inherently absurd, as well as totally unnecessary; and he loses no opportunity to say so in varied and vigorous words.

One not acquainted with Richet's standing as a scientist, and prone therefore to imagine that he may have established a lower standard of verity for his psychic facts than would be permitted in more conventional branches of science, would be disarmed by the chapter in which he discusses the role played by conscious and unconscious fraud of all types, by mathematical probabilities and accident, and by observational error. Throughout the book, too, Richet continually meets such a critic on his own ground by making, himself, any unfavorable judgments which are called for by the conditions of observation or of reporting surrounding the cited facts.

Putting the Facts in Their Places

Though the task of the book is thus primarily to summarize the evidence, it makes a further contribution than this. It does not, to be sure, attempt any theorization. But it does aim to present the facts in such fashion that the nature and content of the subject matter shall be less vague than heretofore. The classifications into which Richet groups his data, and the names which he manufactures for many of these categories, are themselves a large contribution toward the lucidation of psychic science.

The same large division of the psychic field into subjective and objective that all of us make, Richet must make too. Within the subjective field he coins a term of great utility. It is quite plain that, when writing automatically, speaking with automatic voice, seeing clairvoyantly or hearing clairaudiently, etc., etc., there are two entirely different aspects to be considered. The anatomical machinery of the voice or the pen, the subjective apparatus of the vision, hallucination, or what not, constitute one of these. The question how there came, within the physical shell of the sensitive's brain, information which does not normally belong there, is the other, and quite other. Richet postulates, from his array of facts, that "human intelligence includes a special and mysterious faculty which reveals certain facts—past, present or future—that the senses are unable to supply." To this faculty he gives the self-defining name "cryptesthesia." This includes practically the entire range of subjective phenomena, considered from the side indicated. It certainly includes telepathy, and Richet gives an admirable discussion of this point, the extent to which telepathy alone is sufficient to account for all the facts, etc. He also indicates the phenomena of normal psychology having resemblance to cryptesthesia; and he gives a very complete discussion aimed at ruling out the possibility that everything cryptesthetic can be accounted for on the basis of extreme hyperesthesia of the ordinary senses.

Hallucinations and "Hunches"

Cryptesthesia, he tells us, is classifiable into two broad categories—experimental and "sporadic," or as we should prefer to say, spontaneous. He cites a large number of experiments tending to show a certain cryptesthetic faculty in normal individuals—experiments in systematic guessing in which the results were anywhere from twice to ten times what they should have been through pure chance. He then discusses cryptesthesia under actual hypnosis, and under the conditions of the spiritualistic seance. A special category is reserved for "cryptesthesia by sensitives" under conditions not those of the seance room—psychometry, crystal-gazing, and the like. For some reason, though automatic writing gets no special mention as such, being mentioned only as is convenient, in connection with its purely cryptesthetic aspects, "xenoglossis," or vocal use of a language never learned by the sensitive, is given a place of honor as a distinct phenomenon. The evidence of its occurrence, however, Richet judges—with apparent reason—to be of low grade.

THERE is no monopoly in psychic research. While the SCIENTIFIC AMERICAN *has been making its contribution, other people and other bodies have been making theirs. Space forbids our giving detailed accounts of other work than our own. But this month we enjoy a hiatus in our own work, and we are very glad to fill the gap with this review of the two books which we regard as the most significant additions of recent months to the field of psychic literature.*—THE EDITOR.

Coming now to the spontaneous side of cryptesthesia, Richet finds that these monitions, of one sort or another, are of such rich and varied occurrence as to justify giving up 100 pages—out of 626—to them. He discusses quite fully the criteria which must be applied before a monition may be recognized as such, rather than as mere chance. The conditions under which they occur and the symbolical form taken by the presentment are analyzed. The outstanding monition is, of course, that of the death of a friend or relative—more usually, in the literature, referred to as "death-time hallucinations." Richet, however, makes three other important groups: collective monitions that are non-simultaneous and non-identical; simultaneous and collective monitions; and non-collective monitions other than those of death.

These monitions, of course, take various apparent objective forms such as the auditory or visual hallucination, the strong sense of presence of or disaster to the object, etc., etc. Richet separates them strongly from *premonitions;* and rightly, for the monition implies nothing more serious than clairvoyance, while the premonition, if verified in a sufficient number of cases to avoid the possibility of chance, ranks as outright prophecy. We find that in spite of their more critical character, Richet is able to spread some fifty pages of premonitions upon the record.

The Significance of Prophecy

This might raise the question whether we should regard these predictions as cryptesthetic; or whether that term should be reserved for manifestations that involve no looking into the future. There would be some ground, we think, for the latter course. It might well be argued that ability to divine what is going on at a remote place, now, or what went on at such a place in the past, is by no means so startling as the similar ability projected into the future—or at least, that cryptesthesia regarding present and past will perhaps yield to an explanation which will not unravel cryptesthesia of future events, and that pending full explanation of both we ought to separate them. Richet, however, defines cryptesthesia for the most general case possible—he makes the past, present or future quality of the event a matter of indifference. In this he is perhaps swayed by some such idea as has come into the editorial mind with reference to prevision. Our spiritualistic friends have often granted that there is no serious objection to our preference for the telepathic hypothesis, so long as ordinary evidential material is considered; but have insisted that prophecy forces us into the spirit hypothesis. We have always replied that it must be proved, rather than assumed, that a dead man can do anything which a live man can't do; and that until this is proved, we are going to insist that, if a spirit can prophesy, a living human can prophesy too, and in quite the same way. On this basis, we agree with Richet in his refusal to put premonitions into a package all by themselves. If they occur, they occur; but they do not, as is so often assumed, lean toward any particular explanation, any more than does any other type of cryptesthesia.

The Objective Half

Passing from the subjective to the objective, Richet finds that the field has been rather more fully covered before him than in the subjective case. Under the heading of telekinesis he groups table movements, noises, and raps, and direct writing. A separate category, for no good reason that we can see, is made for levitations. The ectoplasmic phenomena of materializations, of course, require such a category. Richet's citations show that there is more involved in "bilocations" than might be imagined—the simultaneous appearance of a person in two places, the existence of "doubles," etc.; and he makes out a case justifying the separate cataloging of this manifestation. Whether haunted houses are a separate thing as he makes them, or a combination of his other groups of objective phenomena, might be questioned. Richet's summary of the evidence throughout the objective half of the field is of equal value with his summary of the subjective evidence; but he makes no such suggestive a contribution to the machinery of discussion. We can do no better for Dr. Richet than quote the opening sentences of his chapter of summary and general conclusions:

"I have now reached the end of this long investigation. I have endeavored, while giving a place—possibly too large a place—to my own researches, to collect the documentary evidence so widely scattered in many records, and to put some order into a matter which up to the present has never been synthetically studied. I have tried to extricate the sciences anathematized as occult from the chaos in which they were involved, and to put in a clear light knowledge that official science, in the pride of its reputation, has refused to consider. It has seemed to me that the time has come to claim for psychic science a place among recognized sciences by making it conform to the rigor and the logical treatment which have given them their authority. . . . It has appeared to me, as doubtless it will appear to every impartial reader, that there are too many well verified facts and rigorously conducted experiments, that chance or illusion or fraud should always be attributed to all these facts and experiments, without exception."

Anyone who has not brought to this subject the will to disbelieve, who has not made up his mind in advance in the sense decried by Richet, will enjoy the book, in spite of its length and its rather formidable title. And after it has been read, it will be found an enormously valuable psychic encyclopedia and bibliography. Practically all the respectable evidence is here, and in every case there are citations of the sources.

Schrenck Notzing and Eva C.

Of different character is the other outstanding contribution to the psychic literature of 1923. "Phenomena of Materialization," by the Baron von Schrenck Notzing, is the record of the author's four years' work with the French medium Eva C. Every sitting is described in full detail, and there are 225 photographs, practically all of them seance-room flashlights. The

(*Continued on page 214*)

When Beavers Aid Irrigation

Emergency Use of the Water Impounded by the Industrious Animals

By Ivan E. Houk

THE natural trait of beavers to build dams for the protection of their homes has long been known, but it is only recently that its economic value has been recognized in irrigation work. The United States Forest Service, in a recent survey of the Cochetopa National Forest, near the San Luis Valley, Colorado, made by Fred Agee, United States forest supervisor of Salida, found that the water stored above the dams in that forest alone amounted to 1241 acre-feet; that is, enough water to cover 1241 acres one foot deep—the equivalent of 24,000 Colorado statute inches running for 24 hours, or enough to irrigate 30,000 acres of land for one day.

Mr. Agee's survey, which was carefully and thoroughly conducted, showed that in the Silver Creek Valley alone, 46 dams were located in a total length of about 5¾ miles. These dams averaged about 660 feet apart, although they generally occurred in groups with a somewhat closer spacing. In some cases the water was backed up above the dams to depths as great as 5½ feet. If these structures had been built of concrete, by man, and the concrete had cost $5 per cubic yard, a very conservative estimate, the dams would have cost from $11 to $1026 apiece, and their total cost would have been about $10,000. This is for the Silver Creek Valley only. Considering the entire Cochetopa Forest the total cost of the beaver dams, on the same basis, would be about $200,000.

Consequently it is evident that the value of the beaver as an aid to irrigation is of no minor importance. In fact a plan has already been developed and put into operation in Colorado, whereby beavers are taken from one section of the State where they are plentiful, and transplanted, as it were, to other sections where their services are more essential, the animals being trapped in huge wire nets placed on the dams. One case is recorded where a rancher, who had only enough water to irrigate a small garden plot before he imported beavers, now has sufficient water to cultivate forty acres successfully.

The plan followed is to save the beaver storage until late in the summer, when water is scarce and crops are badly in need of moisture, then to cut the dams and allow the water to drain into the irrigation ditches. Within 24 hours the beavers have the dams repaired so that they are again storing water for another emergency. Thus the beaver storage can be utilized several times in one season if necessary.

Beavers build their dams of trees, bushes, sticks, weeds, and so forth, cementing the materials together with mud and rocks. Beaver dams 600 feet long, and flooding many acres of land, have been found in northern Wisconsin. Sometimes, after years of work, the dams become solid banks, through which the water passes only by percolation and on which trees, such as poplar, willow, and birch, take root and grow. If this occurs where the natural slope of the stream bed is comparatively flat, marshy ponds and even peat bogs are formed.

Beavers bring trees down by cutting around them with their sharp, tough incisors, in practically the same way the woodsman does with his axe. One instance has been recorded on the upper Missouri where a tree 36 inches in diameter was felled by beavers. They strip the trees of their branches, then cut the trunks into lengths of about three feet, and store both branches and trunks near their homes, for their winter's food supply, placing them at the bottom of the pond and weighting them down with mud and rocks. In the summer they live on roots, berries, leaves, and aquatic plants, but in the winter they eat of the bark of the trees they cut down during the autumn. One carefully watched colony of beavers gathered 732 sapling aspens and several hundred willows for one winter's supply, placing them in a pile over 3 feet deep and 124 feet in circumference. After they have eaten the bark they use the wood in building and repairing their dams. That is the reason the most of the logs and sticks in the accompanying views are bare.

Beavers prefer the bark of deciduous trees, such as the aspen and willow, trees which are of little value as timber. Pine, they never attack. Consequently they are of some added value to the agriculturist in that they tend to rid the country of weed trees. They are strictly vegetarians, as they never eat meat of any kind.

Beavers seldom work in the daytime, but are constantly on the job at night, especially moonlight nights, repairing leaks and improving their structures. The rapidity with which they work is almost marvelous, and their ingenuity in selecting suitable sites for their operations can hardly be improved upon by competent engineers. Their dams are invariably located at the most advantageous sites. In fact their efficiency in repairing leaks under water is so high that they have been used, as a last resort, in stopping leaks in man-built dams.

Beaver dam alongside hardscrabble road in San Isabel National Forest, Col. When these dams occur every few hundred feet along the stream, they impound an appreciable supply of water

Beaver huts and beaver-felled trees; note the neat cleavage, and the similarity to axmen's work

Elasticity and High Speeds

IT is surprising how few men appreciate the importance of elasticity at high speeds and fewer still are able to make their designs so as to avoid trouble. When the ox was the principal means of locomotion, no springs were necessary. The man who invented the bow and arrow was able to produce higher speeds than any before used by utilizing the elasticity of the wood. Many designers of limited ability are able to succeed by making things too strong. This works all right in many cases but not always. The writer has before him now a case where the design of a turbine supporting steel framework was made very heavy by some one who thought that the best way to avoid vibration. The result was that the rigidity of the steel was just right, in connection with the weights supported, to "tune in" with the turbine speed, and excessive vibration resulted from the combination.

To determine the critical speed calculate the deflection of the spindle or beam or the compression of a column due to the weight of the parts and all attached parts. If the deflection is 1/360 inches, 3600 will be the critical speed. (This last is a very common speed and the figures being the same they can be remembered.) Do not forget, however, that figuring the deflection due to weight is only a convenient way of getting the answer, for vibration has nothing to do with gravity and it can take place horizontally as well as vertically so it is wise to go through calculations for deflection as if gravity did act horizontally. For other deflections the speed will vary inversely as the square root of the deflection. Thus for 1/90 inches, the critical speed is 1800 revolutions.

For steel it is customary to figure 29,000,000 as the coefficient of elasticity. There are certain conditions, however, where we have found that this figure is greatly different. Bulletin 219 of the Bureau of Standards gave us a hint in this direction but even the men who made the tests recorded in that Bulletin did not realize the importance of the results. They doubted their accuracy and were unable to realize why they differed from results obtained by others. We have proved that in cases where the forces are all or mainly tension, speeds are high and metals are warm, the modulus of elasticity for steel may be below 10,000,000.—*By A. T. Kasley, Westinghouse Research Dept.*

The Story of Steel—III

The Ore Ship of the Great Lakes; the Link Between the Iron Mines and the Smelting Furnaces

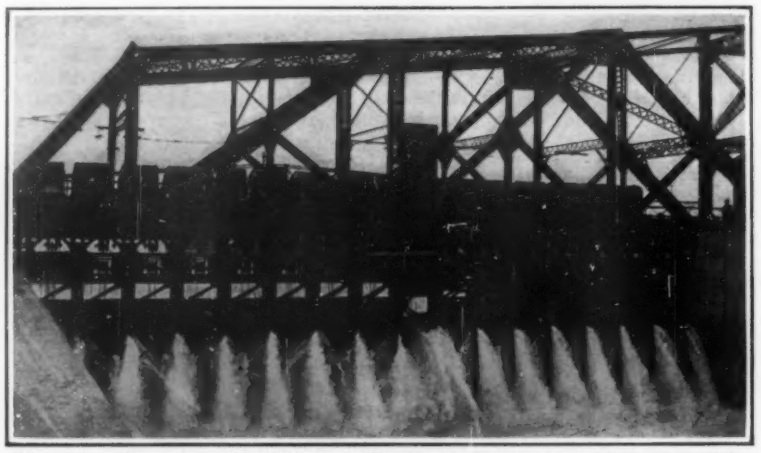
In this great yard, 2½ miles in length, are 96 parallel tracks. Here the ore cars are automatically weighed and reassembled, according to the character of the ore, for shipment to the ore docks. This yard has handled 22,000,000 tons in a single season

WERE it not for the existence of the Great Lakes, the vast mines of the Missabe would be an asset of questionable value. To produce steel cheaply you must have abundant supplies of three things—iron ore, coal, and limestone. Moreover, they must be available in enormous quantities and located reasonably near to one another. It is for this reason that steel works, the world over, are to be found in the vicinity of coal and iron ore; or are so located, that the raw materials can be brought to them at a reasonable cost of transportation.

Now the Lake Superior iron mines are grouped around the westerly end of Lake Superior, and at a distance of from 800 to 1000 miles from the coal fields. If the iron ore had to be hauled that distance by rail, the cost would be prohibitive. Fortunately, when nature, ages ago, prepared the ore beds of the Missabe range, she grouped them within easy reach of that magnificent body of fresh water known as the Great Lakes. It merely remained for man to develop the proper methods of handling and the right kind of ship, to bring these vast deposits cheaply to the storage yards of the blast furnaces. The present chapter in the story of steel shows how cleverly and on what a vast scale this has been done.

The largest tonnage of ore moved over the Great Lakes in a single season was during 1916, when 64,734,198 gross tons were carried through the Lakes. For a comparison of the cost of moving this tonnage, let us take the year before the war, 1913, and let us consider the Lake Shore Railroad which, because of its easy grades and fine roadbed, is ideal for cheap transportation. In that year the freight rate was 5.29 mills per ton-mile. In the same year the freight rate per ton-mile on the Great Lakes was 0.68 of a mill. Of course, the charges both for steamer and rail have gone up; but they have advanced proportionately and the relative cheapness, as between steamer and rail, holds good today. These figures show what an absolutely necessary link in the vast steel industry of the United States is that thousand-mile stretch of water between Duluth and the steel works on the southern shores of Lake Michigan and Lake Erie.

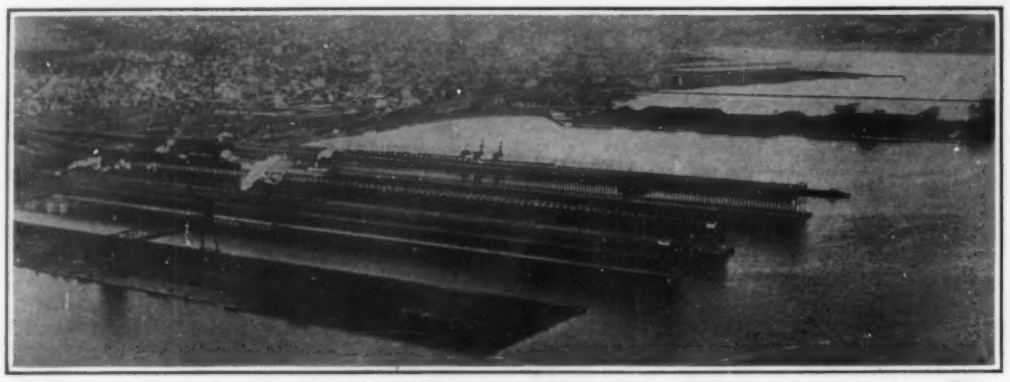
In our last issue we showed how, by the combined use of the steam shovel and the ore train, there was shipped out of the Hull Rust Mine alone, in 1916, a total of 7,665,611 tons of ore, and that the total output from all the mines of Lake Superior was 62,836,172 tons. It is the purpose of the present story to show how this vast tonnage is brought down from the mines to the ore docks, transferred without delay to a great fleet of ore steamers, carried through the Lakes, and unloaded at or near the various steel works in the lower Lakes.



Emergency dam above "Soo" locks. Should a lock gate be carried away, this bridge is swung across the entrance, its vertical wickets (steel plates) are lowered and the rush of water checked

At the Hull Rust Mine, which is the property of the United States Steel Corporation, the ore cars, as they are hauled up out of the pit, are made up into trains which average 96 cars, or 4800 tons of ore, per train. As soon as a train is made up, it is dispatched over the magnificent roadbed of the Duluth, Missabe, and Southern Railway Company for the run to the docks at Duluth. Although this is a freight railroad, it is built with 100-pound steel and, in part, with steel ties, and it is maintained in as fine condition as any main trunkline track running out of New York. Here again, nature has favored the steel industry, for the first 70 miles or so of the trip is across a practically level country. The speed of the ore trains is from 25 to 30 miles an hour. They are dispatched at the rate of 30 trains per day, although the writer was told by Mr. W. H. Hoyt, Chief Engineer of the road, that on some days as high as 36 trains have hauled a total of 173,000 tons of ore per day from the mines to the classification yard at Proctor.

It should be explained that the cars of ore are sampled at the mines as soon as they are loaded. The samples go to a chemical laboratory and the distribution of the cars is telephoned from the laboratory to the main scale office at the Proctor Yard, near Duluth, before the train reaches that point. As the trains enter the yard, the cars pass over automatic scales at a speed of two miles per hour. The scales operate automatically, the weighting device itself stamping the gross weight of the car on a card as it passes over the scales. At Proctor the trains are broken up by sorting engines, and the ore from different mines is placed together in train loads, so that when the ore is being shipped through the ore pockets and into the boats, certain definite mixtures of ore are built up, carrying the percentages of iron, silicon, phosphorus and sulphur required at the particular furnaces where the ore is to be smelted. To handle this enormous tonnage, the Proctor Yard has been built with 96 parallel switching tracks. It is 550 feet wide, in part, and 2½ miles in length. We present a view showing only a small section of the yard, with 14 trains standing side by side. The mixing of the ore above referred to is revealed in this picture by the difference in the shade and in the fragmentation of the ore. From the yard the ore is taken down to the docks over six miles of 2 per cent grade, by large Mallet engines with 415,200 pounds weight on the drivers.



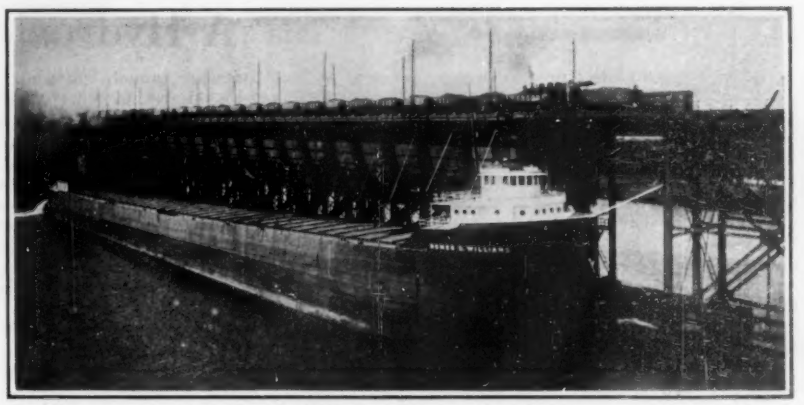
Three of the ore docks at Duluth. Length, 2004 feet. Max. height, 84½ feet. Width, 60 feet. Combined capacity of ore pockets, 345,000 tons. The ore is loaded by chutes to the ship

Nowhere in all America

has the problem of handling and transferring a huge tonnage, in a minimum of time and at a minimum of cost, been worked out to such perfection as is seen in the transportation of ore from Missabe to the far distant steel works. Thus, the unloading from car to ship is done entirely by gravity. To this end a series of huge ore docks provided with pockets has been built along the foreshore at Duluth. We show an airplane view of three docks of the Duluth, Missabe and Northern Railway, with the city of Duluth in the distance. Each dock is 2004 feet in length and the largest is 84 feet 5 inches in height from the water to the deck of the dock, and 60 feet in width. When the ore trains reach the bottom of the hill, they are moved out on to the ore dock and their contents dumped into the ore pockets. There are on this single dock 384 pockets with a total storage capacity of 153,600 tons. The dock is built of steel and concrete, and the bottom of the pockets is 40½ feet above the water. At this level each pocket is provided with a massive hinged spout which is raised and lowered by an electric winch on the floor of the dock. The pockets are spaced twelve feet from center to center, so that when loading is going on the spouts will register with the hatches on the ore ship, which are also spaced on twelve-foot centers.

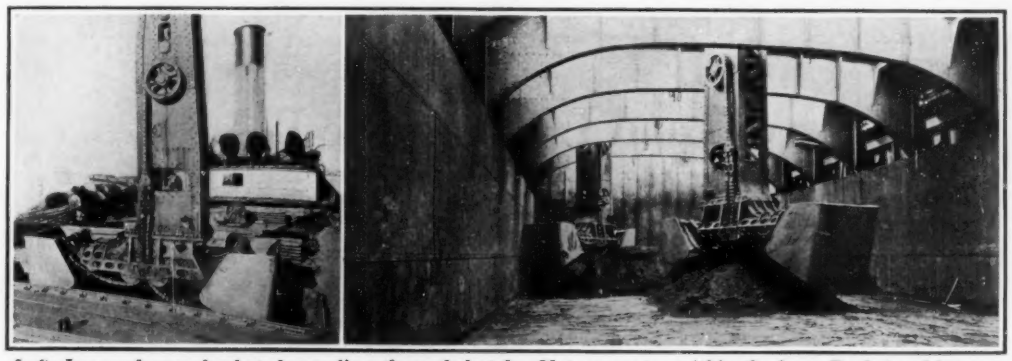
An entertaining chapter might be written upon the development of the ore-carrying craft of the Great Lakes. We must content ourselves here with stating that the first shipment of iron ore took place in 1853, when 152 tons were shipped from the Cleveland Iron Mining Company to the Sharon Iron Company, Sharon, Pa. Lake transportation was done in those days in little vessels of twenty tons burden or less. As the years passed the shipments and the vessels that carried them grew in size—slowly at first and then with increasing rapidity—until today the typical ore ship is a vessel over 600 feet in length, 60 feet in beam, and capable of carrying from 10,000 to 14,000 tons of ore. These vessels have been developed purely along utilitarian lines. With their long, narrow, shoal bodies, broken by deckhouses only at bow and stern, they have none of the beauty of sheer and sweetly moulded lines which is found in an ocean-going liner. But for their particular work of carrying a huge cargo at a fair speed, and of being loaded and unloaded rapidly, they are a positive triumph of human design. In a test of the steamship "D. G. Kerr," to see just what could be done in the way of quick loading, 12,817 gross tons of ore were unloaded from the ore pockets to the hull in 16½ minutes at the D. M. and N. docks, and as a record of quick unloading at the steel works we may note that eight Hewlett unloaders at the Ashtabula pockets have unloaded 70,000 tons from seven ore boats in 22 hours, actual time, and 13,000 tons have been unloaded from a single boat in 3½ hours.

The writer, on reaching Duluth from the Hull Rust Mine, arranged to make the trip through the Lakes on a typical ore steamer, the "Thomas F. Cole" (Captain W. E. Stover), one of the fleet of 99 ore boats of the United States Steel Corporation. While the "Cole" was still warping alongside the ore dock, the spouts of alternate coal pockets dropped down above the respective hatches of the ship, the gates of the pockets were tripped, and 17 cataracts of ore began to stream down into the hull. Meanwhile, two big streams of water ballast from 14-inch and 9-inch pumps were being discharged from the ship's side tanks. Care has to be taken to load the ship evenly and avoid any concentrated bending stresses. By means of wire cables and powerful winches on board, the "Cole" was moved along the dock so as to receive the proper grades of ore to make up the right mixture for the Lorain Steel Works, to which she was bound. In 2½ hours' time about 12,000 tons of ore had been taken aboard, the hatches closed and the mooring cables cast off. It was a novel experience to stand on one side of the deck and line up the opposite rail against some mark on the dock, and note how rapidly the ship sank in the water. Such rapidity of loading is not approached anywhere in the world.



Loading an ore ship. Ore dock chutes are spaced 12 feet, so are the hatches of ship. In one test, 12,817 tons were shot aboard in 16½ minutes

We have said that the Great Lakes ore boat is a very special type. It looks different from any other and its internal construction is decidedly different. Strictly speaking, these vessels might be called magnified canal boats, with the pilot house and captain's and crew's quarters occupying the first hundred feet from the bow, and the bunkers, engine room and engine room crew accommodations filling up the last hundred feet at the stern. The remaining 400 feet of such a ship as the "Cole" is given up to the carrying of ore, or on the return voyage, to a cargo of coal. A midship cross section shows two wide water ballast tanks, one on each side, extending throughout the ship, and a series of 34 deep and stiff girders extending from side to side to hold the hull to shape and carry the hatch covers. Returning light, the "Cole" will carry normally in the tanks from 4000 to 6000 tons of water ballast. She is driven by triple expansion engines, steam being supplied by two Scotch boilers at a pressure 170 pounds per square inch. With a horsepower of 2150 and 84 revolutions per minute, she makes about 11.4 knots loaded. Her average load last year for ten trips was 12,189 tons of ore. The consumption of coal per day is only 48 tons. A truly remarkable performance considering the load and the speed.



Left: **Leg and open bucket descending through hatch. Note operator within the leg. Buckets of largest unloaders, when open, span 22 feet and pick up 17 tons.** ***Right:*** **Cleaning up inside hold**

A 12,000-ton ship in the "Soo" locks. Astern, in same lock, is another ship of 13,000 tons. In 1916, there passed through the six locks 91,888,190 gross tons, of which 64,734 tons was ore

The writer has voyaged in his time on all the seven seas, and in every size of craft from a 150-ton coasting schooner to the "Leviathan" of 64,100 tons displacement, and he thought that he knew something about navigation and the ways of ships and the sea; but that trip down the Great Lakes was a revelation. Not merely the ships, but the way in which they are sailed afford a positively novel experience. In the first place, one is practically never out of the sight of other boats. Ahead and astern will be other ore boats going the same way, and generally at about the same speed; and in the narrow waterways, the returning empties stream by one almost like taxicabs down Broadway, New York. This is an exaggeration of course; but the reader will understand what is meant when he is told that after leaving the "Soo" locks, we met and passed in the channel no less than 24 big cargo boats, most of them of 10,000 tons or more, in a distance of twelve miles. Moreover, at this point the channel was usually only some 300 feet in width. Such congestion would call for most careful navigation even in clear daylight weather; but that particular twelve miles was navigated in the late afternoon, and when the dusk of twilight was deepened by the prevalence of heavy smoke from the autumn forest fires. Not soon will the writer forget the eight hours from late afternoon to after midnight, that he spent in the pilot house. At the open window, glass in hand, stood the captain, watching for those two white lights at the masthead of approaching ships to slow up through the murk, and sounding at intervals the three warning blasts that are characteristic of Lake navigation. Presently, out of the blackness would be seen the lofty masthead lights and then the red and green lights, of an approaching freighter. Speak of searoom! To our unpracticed eye it looked as though collision was surely inevitable. Then, and not so many hundred yards distant, the green light would be shut out. Presently, there would loom up the black, high bow of an empty ore boat, and she would sweep by so closely that one could literally have tossed a biscuit aboard. How different from the transatlantic ship which, as soon as she has dropped the Sandy Hook pilot, travels on a clearly defined easterly course, and knows that the westbound ships are on their own course many miles to the north.

The open season for getting down the huge tonnage of ore on Lake Superior is only eight months in length. Hence, all possible speed is made in the turn-around at terminals and during the passage. When the captain takes his ship out for its first trip in the middle of April, he knows that he is practically setting out on a voyage of 40,000 miles, which lasts from the middle of April to the middle of December. There is practically no shore leave for him and his crew. Before he has completed tying up at the ore docks the ore is pouring into his ship. Before he has completed tying up at the steel works, the huge unloaders are diving into his hold to bring the ore out. It is a strenuous life, and the three months of rest during the winter are well earned both by captain, crew and ship. Each vessel, it need scarcely be said, undergoes during the winter a very thorough overhaul, and it has to be put into absolutely first-class condition. The few hours stay in port afford the engineer no opportunity to lift cylinder covers or make any major repairs. As we have said, it is practically a continuous 40,000-mile voyage of eight months.

That excellent body of technical engineers known as the Corps of Engineers, United States Army, have had

(*Continued on page 216*)

A Hydroelectric Giant

TWENTY-FIVE years ago, the SCIENTIFIC AMERICAN contained illustrations of a hydroelectric unit which, because of its unprecedented size, was the wonder of its day in the electrical world. This was an electric generator driven by a water turbine of 5000 horsepower. It formed one of ten such units which filled the power station of the Niagara Falls Power Company, who were the first to develop on a large scale a part of the potential powers of the Niagara Falls. Five years later, in a comprehensive article on Niagara's developments, we recorded the emplacement of 10,000-horsepower units in the plant of the Ontario Power Company, and of 13,000-horsepower units in the plant of the Electrical Development Company, both of these being on the Canadian side of the river.

In the two decades which have passed since then, there has been a steady growth in the size of hydroelectric units, and during the last two or three years this growth has taken a spurt that has brought some truly astonishing machines as regards their size, weight, power and above all their economy. In California there are being installed 35,000-horsepower turbines for the Southern California Edison Company, and 40,000-turbines for the Pacific Gas and Electric Company; while, at Niagara, waterpower is being developed in the Canadian plant at Queenstown in five enormous machines of 55,000 horsepower each. The latest development is at the plant of the Niagara Falls Power Company on the American side of the river, where the world's largest hydroelectric unit of 70,000 horsepower was placed in commercial operation in December by a delegation of hydraulic and electrical power men and government officials. This is the first of three such turbines with which this station will shortly be equipped.

The water for operating the new station is withdrawn from the Niagara River above the rapids. It is carried beneath the city of Niagara through a new hydraulic pressure tunnel, which measures 32 feet by 32 feet and is 4300 feet in length. The tunnel terminates at the edge of the high cliff on the American side below the falls. It is excavated through solid rock, and the material removed would fill a train of gondola cars reaching continuously from Buffalo across the State to Utica. The tunnel discharges into a large forebay, from which the water is led to the turbines in the power house at the foot of the cliff, by means of three 21-foot, slope-tunnel penstocks cut through the limestone cliff. After doing its work on the turbines, the water discharges into the Niagara River.

This giant unit weighs more than 1750 tons. It consists of a 70,000-horsepower, single runner, vertical shaft, hydraulic turbine, attached to an electric generator delivering 52,000 kilowatts at 12,000 volts. When completed, the station will house units with a total rated capacity of 454,000 horsepower. The company has two other stations with rated capacities of more than 200,000 horsepower. The annual output of the American Niagara system alone is in excess of two billion, five hundred million kilowatt-hours, and represents about one-third of the electricity sold in New York State.

The new hydroelectric unit uses 3200 cubic feet of water per second, with an efficiency of at least 93 per cent. It does not increase the company's diversion of water in any way, but does materially increase the efficiency of conversion into power. It uses the same amount of water formerly used by seven 5000-horsepower units and delivers energy equivalent to the output of 14 such units. Each of the three new 70,000-horsepower units will produce electricity which, if generated through the use of coal, would require 700,000 tons annually. Although the new project will not use any more water than is now used, it will so use the water as to produce an increase of 100,000 horsepower in the power output of the station.

The turbine of this unit is the highest power-capacity water-wheel ever built. It is a product of the I. P. Morris division of The Cramp Ship and Engine Building Company of Philadelphia. Specially designed cars were required to transport the great castings assembled into this turbine. The runner is a single-piece, steel casting, weighing 105,000 pounds. The turbine casing and control valve required 32 carloads of parts. The turbine converts the power of the falling water into mechanical energy, which is directly transmitted by means of a 32-inch shaft to the generator set immediately above.

The great generator sets a new high mark in design and construction of electrical equipment. The stator of the generator weighs 228 tons. The rotor, with its twenty-eight 8-ton poles, measures 21 feet in diameter and weighs 399 tons. The revolving elements consist of rotor, shaft, and runner, the total weight being approximately 500 tons, and they are suspended from the top of the unit by a Kingsbury thrust bearing. The generator was manufactured at the Schenectady works of the General Electric Company.

The transmission lines radiating from Niagara Falls serve a vast community, stretching from Erie and Jamestown on the west to Syracuse and Oswego on the east. The flow of these veritable rivers of electricity will be substantially increased. East of the 147 communities in the 16 counties now served will enjoy more and improved service, and some two million people will share in the increased power produced by this project. However, in spite of the additional energy from this new unit, as well as the energy to be produced by the other two big machines which go into service during the coming year, the demand for cheap, constant, Niagara hydroelectric power outruns the supply. New domestic and industrial uses of electricity are constantly developing, and no further increase in output can be effected until present restrictions of the use of the waters of the Niagara River are modified.

Does Land Lie Near the Pole?

WHILE only about 35 per cent of the earth's surface has been subjected to civilization, more than 95 per cent has been explored, charted, and ticketed for future human usage. Of the remaining 5 per cent the most mysterious and alluring part is without doubt the 1,000,000 square miles of unknown Polar Sea that lies directly northward from Alaska.

Next June or July Amundsen's three planes will fly from the old Zeppelin trans-polar base in Spitzbergen directly across this unexplored area. One of these planes will be in charge of Lieutenant Davidson, U. S. N. The Navy Department has officially announced plans for a prospective flight of the new navy dirigible, the "Shenandoah," across the top of the world.

The chances that land will be found by these fliers are about five to one. Even if there be no actual polar continent, there is still every prospect of polar land. Vast ocean spaces are not infrequently dotted with broad-topped fertile islands jutting from their depths and having no connection with any continental mass. The single feature in common among such islands is their situation on or near a line of volcanic activity. This fact contributes one of the solidest reasons for believing new land lies near the North Pole.

Japanese-Aleutian lines of the subterranean activity point poleward. Down the other side lie Spitzbergen and Iceland. The latter is one of the most intensely volcanic spots on the globe. So it is reasonable to conclude that somewhere between Iceland and Alaska in the Arctic Ocean may lie a similar nubble of land upthrust through the polar pack.

Even more substantial evidence of a polar land issues from the results of northern data worked up by the tidal expert, Dr. R. A. Harris of the United States Coast and Geodetic Survey. He fitted together such bits of evidence as the drifts of the Fram and the Jeanette, observations of movements of the pack-ice, rise and fall of tide in Greenland and Alaska, and so on; and he concluded that there must be a "large body of land or shallow water as yet undiscovered in the polar regions."

Supplementing theoretical deductions are several reports of whalers and northern travelers who claim they actually sighted land. Chief among these is Admiral Peary's experience in 1906 when he went westward along the shore of Grant Land on which the "Roosevelt" was wintering, and saw distinctly the "snow-clad summits of the distant land in the northwest above the ice horizon." And whalers off the coast of Alaska, penetrating in open seasons to high latitudes, a dozen times declare that they have sighted the shores of new land looming through the arctic murk.

A new Polar island or continent will likely be in some respects radically different from other lands bordering on the northern sea. In the first place its volcanic origin would make for a more rugged terrain than the low barrens and tundra of North America or the flattened steppes of Siberia. In view of the considerable interval between known lands and the new land its meteorological features would probably be different. There would be enough less precipitation to prevent the formation of large glaciers such as are found along Alaskan and Greenland coasts. Without such flowing water there should be relatively less weathering than further south. The work of frost would be the chief agent of rock disintegration.

It is unlikely that any new species of animal or vegetable life would be found upon it. But we might expect nearly anything in the way of mineral resources. Coal unquestionably, for coal is being found in the Arctic in ever-increasing quantities. If the new land is anything like Alaska it will be a find indeed.

The new land would by no means lie beyond the line of human habitability. Spitzbergen's coal mines, which have been profitably worked, are in almost exactly the latitude of the center of the unexplored region north of Barrow.

But before we could lay claim to all these riches we must land and take possession. That is a more serious matter than it seems at first sight. In the first place the Polar pack is a vast disk of rough and nubbled ice some 2000 miles in diameter. This disk is constantly surging back and forth under the influence of tides and winds. Where it collides with any land mass it is torn and shattered by the impact. Thus along its fringes the polar pack possesses a band of "pressure" ice from 20 to 50 miles in width. For a plane or dirigible to land in this area of wreckage would be suicide. The one real chance for setting foot on the new land would lie in the fact that, when wind and tide break leads in the heavy pack, these leads are open water until the wind or tide changes again. For a brief period they afford proper landing area for a seaplane.

It has been suggested that the land be first located from the air and then explored by Peary sledge methods from a base at Point Barrow. On the final North Pole dash from Cape Columbia on the northern coast of Ellsemere Land Peary's goal was about 500 miles from his point of departure. But Barrow is 1117 miles from the Pole, twice Cape Columbia's distance. Movements of the ice-pack thereabouts are more eccentric than in any other part of the Arctic. One may go to bed with a solid jam right on the beach and wake up with no ice in sight; open water clear to the northern horizon. Such movement would be disconcerting to a sledge expedition, to say the least.

Before the problem of accessibility of the new land has been solved a party might be established there from planes, having taken chances on smashing their machines. With kites or captive balloons radio aerials could be raised and communication attempted with the southern base. The weak point in this plan is that MacMillan's outfit at Etah and Amundsen's vessel, the "Maud," drifting north of Siberia have both demonstrated the presence of a mysterious radio barrier that exists in high latitudes during the summer months. Whether this is a direct corollary of the constant daylight or a result of the excess static existing over the Polar Basin cannot yet be said.

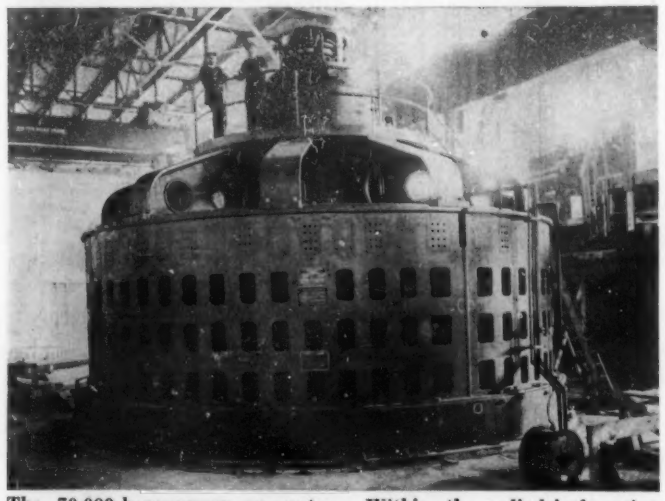
Even after reaching and occupying the new land the question of creating an unassailable claim to it is by no means a simple one. By international law territory must be inhabited in some degree of permanency before it can actually belong to the claimant power. There are islands in the Pacific which American mariners have visited and developed, over which we cannot hoist our flag because we have not fulfilled the tenets of the law.

One solution would be to transfer our Eskimos from Alaska there. Eskimos are ethnologically one of the most distinct branches of the human race. Their peace-loving responsive natures have let them in for all the ills and evils of civilization. Isolated in an environment to which they are suited they lead happy and efficient lives.

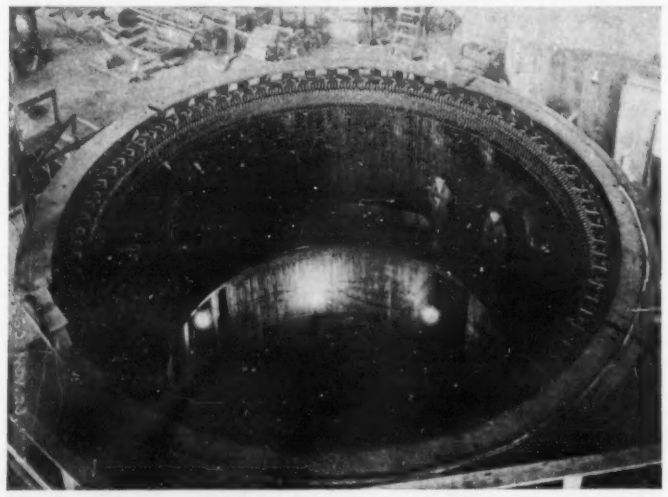
There would be no cruelty attached to such a social experiment. The Smith Sound tribe living on the northwest coast of Greenland are now the most northerly and isolated people in the world. They are healthy and carefree. They are hospitable, proud, capable men and women. They have no desire to go south where dwells the eccentric white man. The latitude of their upper village at Annorotok is nearly that in which inhabitants of the new land would live.

The new colony could not be exploited. Governmental control of its visitors would prevent the poisonous effect of unrestrained civilization from getting in its evil work. Yet development of natural resources or simply the preparation of the place for future scientific investigations could go on.

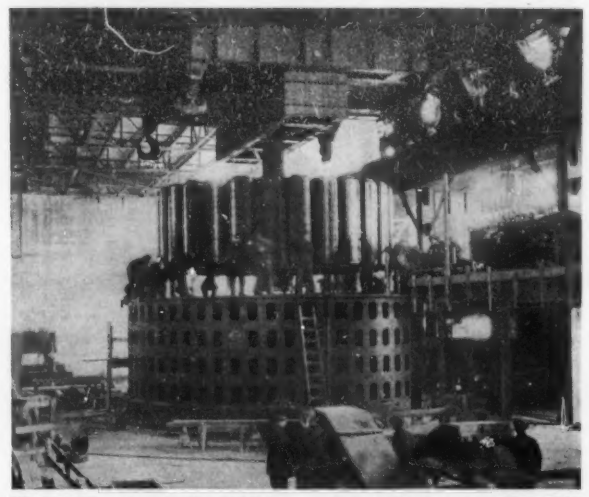
Altogether the chances that new land may be found are good enough to warrant serious search for it. Its conceivable resources and uses augment the urge to open up the great blank space above Alaska. Finally, there is always the vivid fascination involved that the unknown has held for men since the beginning of time.



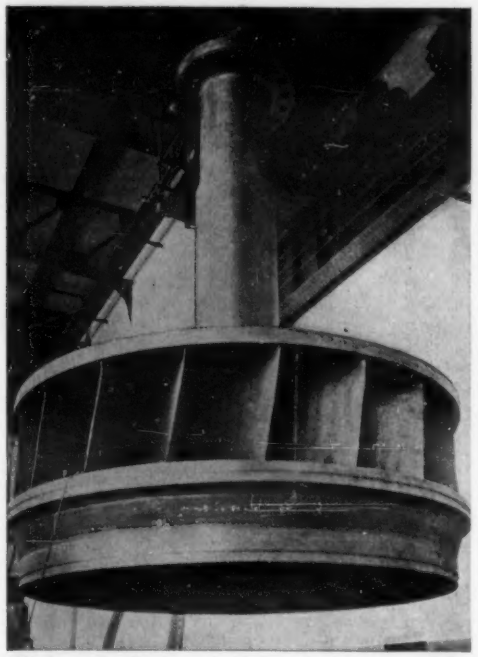
The 70,000-horsepower generator. Within the cylindrical casing are the stator and the rotor, and below the floor is the water-wheel or runner. The heavy steel brackets above the casing hold a Kingsbury bearing, which carries the combined 500-ton load of the rotor and runner which are suspended below it



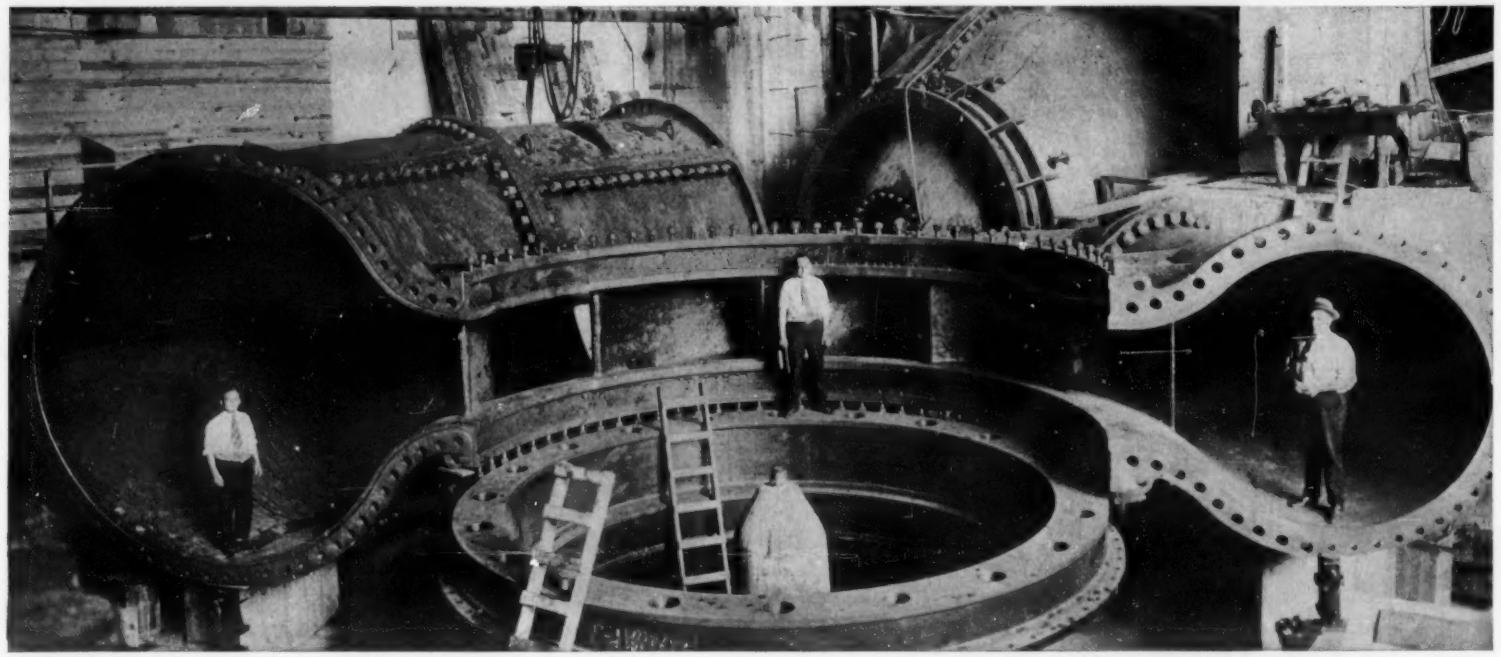
The huge stator or field of the generator. This generator establishes a high-water mark in the design and construction of electrical equipment. The stator alone weighs 228 tons. The two men shown standing within it give an instant impression of the great dimensions of this whole outfit



This view shows the 400-ton rotor, with its twenty-eight poles, each weighing eight tons, being lowered into the stator. The rotor is coupled to the 32-inch dia. suspended vertical shaft of the water-wheel, which is hung below the floor of the generator room



The water-wheel, a single steel casting, weighs 52½ tons. The water rushing through the wheel develops 70,000 horsepower before it is discharged into the tailrace below. This power is transmitted to the generator rotor by the 32-inch diameter shaft above the wheel



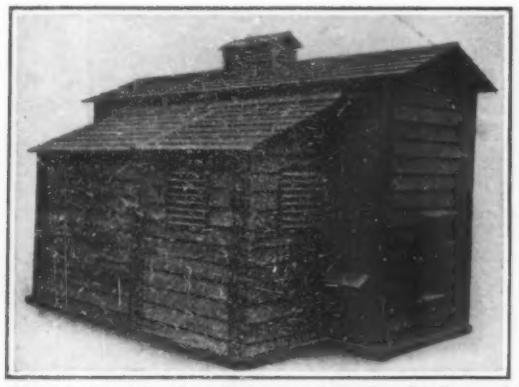
This remarkable view shows where the water, at the rate of 3200 feet per second, is received and distributed around the periphery of the runner. In the upper right center is the inflow tube, with its conical valve for regulating the supply. The water rushes around the great circular tube and is directed into the runner by fixed guide vanes on the inner side of the tube. The tube decreases in diameter proportionately to the amount of water that flows from it to the runner. After it has done its work on the wheel, the water discharges through the circular tube in the foreground. The water for operating this gigantic hydroelectric unit comes from the Niagara River through a new hydraulic tunnel, a distance of 4300 feet, and more directly from a large forebay and a slope-tunnel penstock cut through a limestone cliff. From the turbine, the water discharges into the Niagara River

SOME DETAILS OF THE NEW 70,000-HORSEPOWER, WATER-DRIVEN GENERATOR AT NIAGARA—(See facing page for description)

When a Second Seems an Age

Filming Rapidly Moving Objects by Means of the Heape and Gryll Rapid Cinema Machine

By P. J. Risdon



This light-tight housing contains the high-speed motion-picture camera

IT MAY be said that the object of the ordinary cinema is served when pictures taken of still or of moving objects are reproduced on a screen at such a speed that the eye cannot detect any departure from normal continuity of motion.

But then we come to another aspect, namely, that of photographing bodies in such rapid motion that the eye cannot follow the individual movements, but can only take in the motion as a whole. A galloping horse and most natural animal movements come under this category. In such cases if it be desired to analyze the movements, pictures taken need to be projected at a slower speed.

In the next place there are rapid movements such as those of bullets in flight, falling bodies, and so on, requiring still higher speed photography and slower speeds of projection to permit of the movements being followed by the eye at all. Take the case of photographing a bullet from a machine gun firing 1000 shots a minute: a complete cycle is over in one-sixteenth of a second, during which time a complete set of pictures must be taken. Some very fine results have been secured in this direction, showing just what occurs, for instance, when a bullet strikes a glass globe.

Science, however, could not long remain satisfied with such results, and the Heape and Gryll's Rapid Cinema Machine is the latest forward step in high speed photography. As in the case of many other important inventions, its design, construction and operation are based upon perfectly simple and familiar principles. Yet a complete film comprising 288 photographs, all taken in less than one-sixteenth of a second—at the rate of 5000 pictures a second—is the proved performance of this machine. Not only so, but the pictures can be taken in pairs if desired, so as to produce a stereoscopic effect—a point of very great importance—or a second film of 288 pictures may be taken, following directly upon, and, in fact, overlapping, the first.

The machine, which is of English conception and execution, comprises a large, steel "film" drum about 68 inches in diameter, mounted on a shaft directly coupled to an electric motor the speed of which is variable from 100 to 1000 revolutions per minute. These speeds correspond to from 500 to 5000 photographs per second. The shaft is mounted in bearings carried on steel girders resting upon cast-iron foundation blocks.

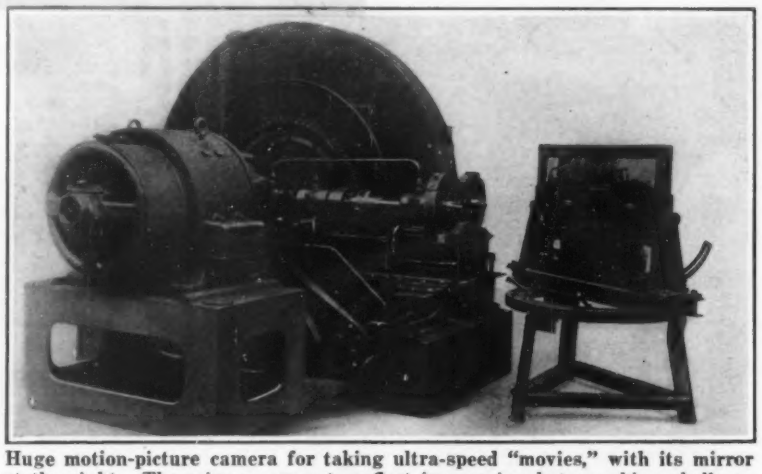
On each side of the drum, and bolted to it, is a circular rack that engages a bevel pinion on a horizontal shaft on the front end of which is fitted a "lens" wheel.

Normally, the outer edge of the drum is cased in to exclude the light, but there is a hinged section of the casing that can be opened for inspection purposes, and for winding on the films.

The drum is wide enough to take two films spaced several inches apart in grooves on the rim. Standard films are employed, so that any film taken may be used in an ordinary projector. The two films, which are unperforated, are wound on the drum, side by side, each making up a single turn on the drum circumference, sufficient for 288 photographs, the two ends being cemented together where they overlap. In order to maintain them in close contact with the drum, air is exhausted from beneath each film so as to obtain a degree of vacuum equivalent to 12½ pounds per square inch below atmospheric pressure. The air is exhausted through a hollow in the drum shaft, by means of a vacuum pump.

The drum, which weighs 1000 pounds and has a maximum peripheral speed of 18,000 feet a minute, is stressed to five tons per square inch at the rim at this speed.

In each of the lens wheels already referred to, 40 lenses are mounted in such a manner that, as the wheel rotates, each lens in succession throws an image on to its respective section of film, the pitch or spacing of the lenses corresponding exactly to the standard pitch of the pictures, namely ¾ inch. The bevel gearing is in such a ratio that the lenses pass the apertures through which the exposures are made, at exactly the same rate as the film. The lenses, which have an aperture of F/4, are focussed by setting the wheels on the shafts, by means of screw thread adjustments, to index marks corresponding to the known distance of the object. The maximum speed of side shafts is 120 revs. per second.



Huge motion-picture camera for taking ultra-speed "movies," with its mirror at the right. The mirror serves to reflect images in photographing shell explosions, thus protecting the camera

An extremely important feature is the shutter mechanism and control. The shutter mechanism comprises a vertical, metal, falling plate that works between roller guides mounted on a fixed casting. This vertical plate and the upper portion of the casting are arranged so that they lie between the films on the drum and the lens wheels. In the fixed casting there is a pair of focal-plane slits, opposite which the two sets of lenses pass. The narrowest focal-plane slit is about one-twenty-eighth of an inch. The lower portion of the casting forms a box in which three spring-controlled electromagnets are housed.

On the upper portion of the falling plate is mounted a disk with two apertures in it. These apertures are crossed by each of the revolving lenses in the corresponding lens wheel. By means of a simple adjustment these apertures may be arranged side by side when stereoscopic pictures are required, or may be staggered so that only one slit is uncovered at a time if two films are to be exposed in succession.

The shutter is suspended from a bracket on the drum casing by a vertical rod, and when it drops its fall is accelerated by strong springs. The first movement of the shutter is controlled by the three electromagnets above referred to, which depend for their action upon an interruption in their electric circuits.

In the case of photographing a shell striking an armor plate, the *modus operandi* of the photographing process is as follows:

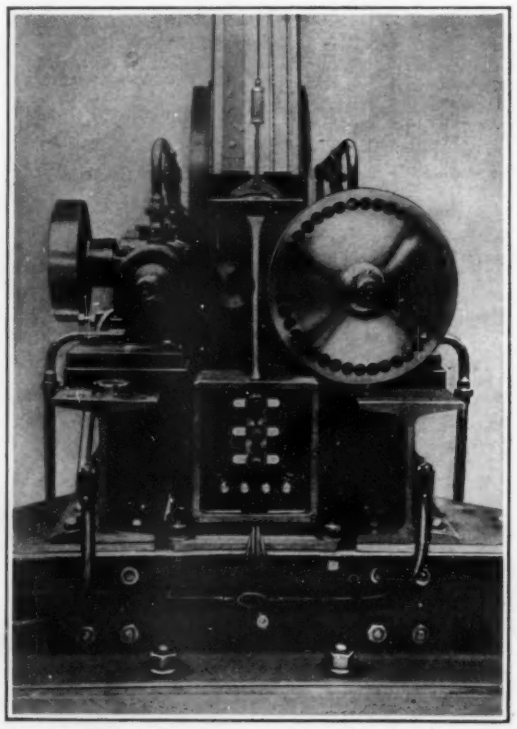
A wire, which completes the electric circuit in which the electromagnets are placed, is stretched across the path of the projectile, at a distance from the target that suits the time lag in the shutter mechanism and the speed of the projectile. The distance is usually about 30 yards. The shutter having been set, according to speed and whether stereoscopic pairs or single photographs are to be taken, and the machine having been started and run up to the required speed, when all is in readiness the gun is fired, and the projectile, on its way to the target, severs the wires in its path, thereby breaking the electric circuit and allowing the shutter to fall and admit light to the revolving lenses through the focal slits, at the moment that the shell strikes the armor plate. In the following one-sixteenth of a second, 288 photographs are taken.

A little consideration will show that, for taking photographs at the rate of 5000 a second, ordinary daylight would not suffice. With a film speed of 18,000 feet a minute and a focal-plane slit of one-twenty-eighth of an inch the time during which any portion of the film is under exposure is only a hundred-thousandth of a second. Special methods of lighting have, therefore, to be resorted to. In the case of a small object not occupying more than a fifteen-inch diameter circle, the beams of say two powerful 120-ampere searchlights with three-foot mirrors concentrated upon it give sufficient light. But in order to illuminate a large object such as an armor plate sufficiently, magnesium or aluminum is employed.

The machine, which without auxiliary apparatus, weighs four tons, is contained in a double-walled, light-tight house, to which access is obtained through an antechamber with double doors, so that the operator may enter or leave without fear of admitting light and fogging the films. Inside the house, a non-actinic, red lamp, lighted from electric accumulators is provided to facilitate changing the films on the drum, for which purpose special mechanism is included for winding the films on the drum from spools, and unwinding them again.

In photographing at close quarters the action of an armor-piercing shell upon an armor plate, the question arises of how to protect the operator and the cinema machine itself from injury from flying splinters—indeed, possibly from destruction. The problem has been solved by arrangements which place the operator in a position of safety and enable the machine to be adequately protected.

By the use of connecting cables, all the controlling apparatus, together with the electric generator, may be placed 500 yards from the cinema machine, so that it is unnecessary for the operator to be within the zone of danger of an explosion, although he can exercise just the same control as though he were on the spot.



Front view of the ultra-speed camera, showing one lens wheel in position and the other removed

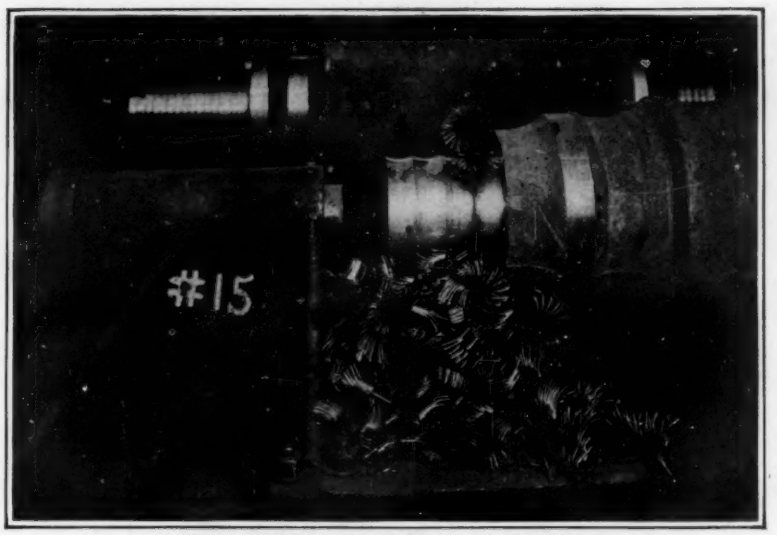
New Ways to Use Slate

HITHERTO, from 80 to 95 per cent of the gross production of all slate quarries in the United States has been discarded as waste. The losses involved in handling so much waste and the consequent added cost of the finished product have resulted in the U. S. Bureau of Mines devoting considerable scientific study and investigation to the problems of reducing the proportion of waste and of utilizing the unavoidable waste. This government agency was not equipped for conducting detailed researches with waste slate-dust so it enlisted the scientific services of the various commercial projects and plants interested in the conservation of slate and these concerns have performed the actual tests under the supervision of the Federal authorities.

The results of these experiments show that pulverized slate, or slate flour, may be used satisfactorily as a filler to give body and to supply the necessary wearing qualities to rubber articles of everyday use such as garden hose, rubber shoe heels and soles, carriage tires, and rubber packing and disks of different kinds. It has also been determined that ground slate may be used to advantage as a constituent of some classes of linoleum, oil-cloth and window shades. The early tests indicate that with finer grinding, this by-product material may prove an efficient filler for the manufacture of automobile tires, phonograph records and other products requiring extremely fine-grained filler.

For plastic roofing and flooring products containing coal tar, powdered slate has long been used and constitutes a most satisfactory filler. The insoluble character of the slate renders it of special value for acid-proof, plastic flooring and as lining for acid tanks. Approximately 75 per cent of the volume of certain types of plastic flooring is composed of ground slate, and according to government reports, several hundred carloads of waste slate are annually used for this purpose. Although pulverized slate will have to compete with established articles which have long been used in the various trades and industries, nevertheless, slate flour is sure to rise rapidly in popularity because in addition to being eminently satisfactory and serviceable, it is considerably cheaper than some of the filler materials such as talc, soapstone, foreign and domestic china clays, pulverized limestone or marble, aluminum flake, whiting, ochre or mineral paint.

The manufacture of filler for road asphalt mixtures is another promising field for slate waste utilization according to the investigations of the Bureau of Mines. In the ordinary preparation of asphaltic mixtures for surfacing roads, finely pulverized limestone or portland cement are used as fillers in addition to the sand or stone and sand aggregates. In asphaltic mixtures, in which by-product asphalt is used, the weights of filler and asphalt are substantially the same, but when certain types of native asphalts are used, a somewhat smaller proportion of filler is required. The amount of such filler annually used in asphalt mixtures is very large, the city of New York alone using more than 50,000 tons a year. Government tests have shown that slate flour is admirably adapted for use as a filler in such asphaltic mixtures and accordingly, it is expected that a considerable amount of waste slate will be devoted to national and state road construction purposes.



The machining of molybdenum steel rolls

Dining Car Profits

WE are apt to complain, when we travel, of profiteering in the dining car. The Pennsylvania Railroad has answered this by a neat little pamphlet in which it shows that the average cost per meal is $1.3831 and the receipts average $1.1682, leaving a loss of $.2149 per meal, or $175,228 annually. Some of the figures of supplies are amazing. In 1922 there were required 427,373 pounds of ribs of beef; 321,888 pounds of loins of beef; 174,802 pounds of lamb racks; 389,498 pounds of chickens, etc. Vegetables, fish, butter, eggs, etc., as well as bakery products hold the same large proportions.

Molybdenum and Its Applications

AS long ago as 1911 it was recognized that steels alloyed with molybdenum possessed valuable characteristics; but this fact could not be commercialized at the time, because the known supplies of molybdenum ore were too small and of too low grade. But extensive prospecting during the war brought to light deposits at Climax, Colo., and Questa, N. M., which put the United States in the position of having a greater supply of this metal than the rest of the world combined. The result has been that today the molybdenum industry is one of the most important branches of American metallurgy.

It is too much to say that the radio development of today has been made possible by any single contributing factor. It is, however, undoubtedly true that molybdenum's availability in commercial quantities has been of as much aid in this development as any other single item. For this is the metal employed in making the grid in that all-essential part in both sending and receiving outfits, the vacuum tube. No other metal gives the same satisfaction here.

But the principal use of molybdenum is in the manufacture of special steels. Wherever it is desired to combine great toughness, great strength, and great resiliency with its corollary of ability to withstand the "fatigue" of repeated stress, there is an opening for molybdenum steel. This alloy is easy to fabricate and to subject to heat treatment, and is cheap to manufacture.

One of the most trying uses to which metal is put is in the springs of taxicabs. It has been found that the average life of these members is from four to six weeks. Experiment with molybdenum steel in Pittsburgh is said to have tripled the life of these much abused members. Again, railroad workmen insist upon using their steel shovels for prying out spikes and nails. It has been demonstrated that a molybdenum steel blade will stand up under this sort of thing far longer than one of more ordinary metal.

Another interesting application of molybdenum steel is in cold-cutting tools. Here are required great hardness and extreme toughness—qualities which contradict themselves in ordinary steel, which becomes more brittle as it is made harder. But molybdenum steel has the hardness and the toughness, and high elasticity in the bargain.

Various automobile parts—axles, propeller shafts, gears, etc.—as well as motor trucks, tractors, heavy machines of all sorts—punchers, headers, reamers and other hot and cold working tools, dies and die blocks, are all made to advantage from molybdenum steel by rolling or forging processes of one sort or another.

There are similarly important uses for molybdenum in the manufacture of cast steel parts of machines, etc. For example, the life of the average crane wheel is about six months. By making this part of the crane from molybdenum steel, its life can be increased two to four fold. At the present time there is a cast chrome-molybdenum steel crane wheel in service for over two years without being re-machined. In fact the metal is worn away on the bearing surface of this wheel for a depth of only one-sixteenth of an inch.

Locomotive frames, large castings for ships, cars, etc., have been made from molybdenum steel, resulting in a material increase in the strength of the different parts. The resistance to sudden shock is thereby augmented by at least 50 per cent.

The I-beams, channels, plates, angle-irons, etc., used in steel building construction, rails, etc., are made by rolling the hot metals between steel rolls. The wear and tear on these rolls is very great indeed. In the accompanying cut there is shown a molybdenum steel roll in the course of actual machining. Attention is called to the large size of the cuttings, which is a very good indication of the toughness of the steel. Ordinarily a steel of similar hardness will not machine so well at all, for the cuttings or shavings will be almost as fine as dust, indicating that while the steel is hard, it is not very tough and elastic. A test of molybdenum steel rolls, made recently, yielded the unequalled production of 625,000 tons of steel before the rolls required repair. In the manufacture of these steel rolls the fact that the heat treatment of the molybdenum steel rolls is carried out with considerable ease is a factor of paramount importance.

In the smelting of molybdenite, which is the principal molybdenum ore, there are produced concentrates, which are roasted and treated with acid to produce a variety of molybdenum chemicals, which are of considerable technical and industrial importance. For example, molybdic acid, phosphomolybdic acid, sodium molybdate and other salts are formed, which are used for various purposes in the dye industry, in medicine and pharmaceutical preparations, and quite extensively in the analytical chemical laboratory.

The molybdic acid may be mixed with charcoal and heated in an atmosphere of hydrogen to produce pure molybdenum powder. This may be compressed into billets and swages, rolled or die drawn into sheet and wire. These products are then used, as mentioned above, in vacuum tube manufacture. The powder is also used as a blue pigment in making fine grades of potteries and porcelains.

A slate quarry in Piscataquis County, Me. The waste due to crumbling and breaking in getting out the slate has been running between 80 and 95 per cent for the entire industry

More Steam-Engine Power Without Steam

Replacing Water and Steam with a Mysterious Liquid and Its Power-Producing Vapor

By Ismar Ginsberg
Chemical Editor, SCIENTIFIC AMERICAN

SINCE Watt first conceived the idea of steam as a power producing medium, there has been little done to replace steam by any other fluid which would give more efficient results. True, there has been the mercury engine development, but this is not as yet thoroughly tried out in the commercial sense. That the engineers should have kept to steam for so many years is not all strange, for water is plentiful and despite the disadvantages occasioned by the use of certain kinds of water which cause the formation of scale on the internal walls of the boiler and boiler tubes, there are many counteracting advantages connected with its use. Every effort has been made to develop a greater degree of efficiency with steam by the use of superheaters, feed-water heaters, condensing engines, etc., but the most that has been accomplished is very small compared to what is claimed to be obtained by the replacement of water by a new fluid.

It is understandable that every liquid that will develop a vapor may, under suitable conditions, be used to develop power in a cylinder. Water is by no means the only substance that will do so. In a certain series of experiments that were made with a view to securing a liquid for use in an automatic fire extinguisher, which liquid would respond quickly to a rise in temperature and rapidly evolve a vapor whose pressure would release the valve closing the extinguisher and throw its contents into the air of the room where a fire had developed, fortuitous circumstances led to the finding of a liquid which was being made for other purposes but which possessed these properties in a marked degree.

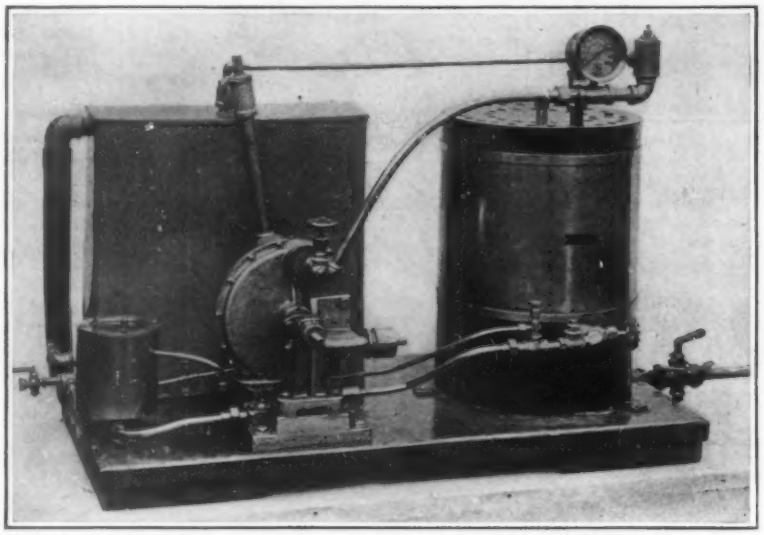
The new power-generating fluid is really a very remarkable substance and actually generates power with an efficiency that far exceeds that of steam. The writer witnessed several experiments made in Philadelphia on experimental engines driven by the new liquid, which proved to his entire satisfaction the various claims made for it by the inventor.

Before describing these tests it may be advisable to say a few words about the liquid itself. It is a water-like, mobile fluid with a rather sweetish odor and a very low boiling point. It rapidly evaporates in the air and chills the hand just like ether or other volatile substances. But while it is extremely volatile, unlike ether it is absolutely non-inflammable and non-explosive. A test was made with the substance by trying to ignite it with a burning match. Not only was the match extinguished by the liquid itself, but a second test showed conclusively that the vapors of the liquid are likewise non-inflammable. The liquid is also non-corrosive. The experimental engines and the various other parts of the apparatus, made from copper, brass, iron or steel, showed no signs of any corrosion either from the liquid or its vapors. In the boiler in which the liquid was heated to convert it into a vapor, there was no deposit. It was said that the boiler had been in use for a considerable length of time; at any rate, for a sufficient length of time for a deposit to have formed.

Perhaps the most remarkable property of the liquid is the ease with which it develops vapor under pressure. The Bureau of Standards has made an investigation of its boiling point and the pressure of the vapor at different temperatures. It is interesting to note that at 212 degrees Fahrenheit, at which point steam has no pressure at all, the vapor of this liquid showed a pressure of 85 pounds per square inch. At a temperature of 422 degrees Fahrenheit, at which point steam has a pressure of 300 pounds per square inch, the new power medium has a pressure of 1000 pounds per square inch.

This is the reason why it is possible to generate considerably more power with the new vapor than with steam, and at the same time effect considerable economy in the consumption of heat. Other physical properties of the new liquid which are of interest are its low specific heat and latent heat of vaporization.

It is evident that the same amount of heat will produce more vapor at a higher pressure and within a shorter period of time when applied to the new liquid, in comparison with water. In other words, the new vapor contains less heat than steam under similar conditions of temperature and pressure. This might lead to the conclusion that it would be impossible to produce power with the new vapor in a reciprocating engine or turbine, because the vapor would condense on expansion, forming a liquid and generating no power. It was similarly argued that it would accordingly be necessary to keep the engine or turbine at an elevated temperature to prevent this from happening, so that the heat saved in the first instance would have to be used in this manner, thus wiping out any real saving in heat.



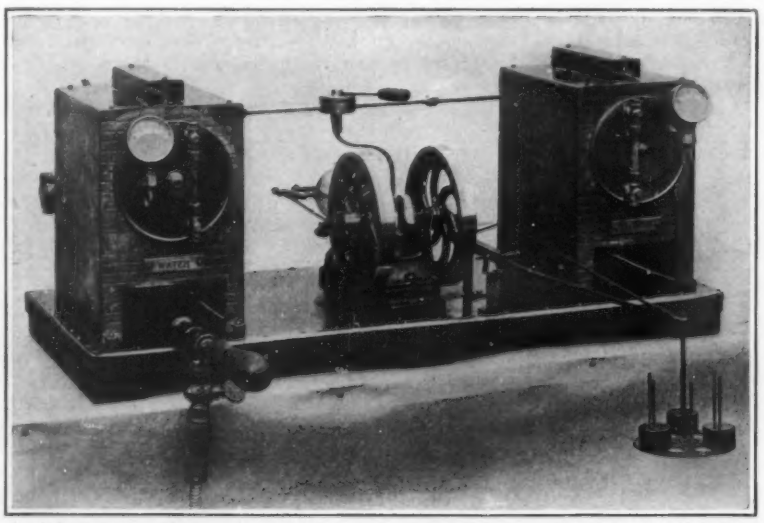
Model turbine with condenser, arranged for operation with the mysterious power-producing liquid which takes the place of water

But this does not happen. Demonstrations made in the presence of the writer proved without a question of doubt that the vapor of this liquid will run an engine or turbine. Just to prove the efficacy of the vapor, a small copper cylinder was filled with a little of the liquid, the cap was screwed on tight and the outlet was connected to the steam cylinder of a small toy, reciprocating engine. The copper cylinder was then held under a stream of hot water running from a faucet. The engine worked splendidly, running at a high rate of speed.

A number of tests were made with a model turbine installation, shown in our first view. This is a closed system, it being a fundamental idea of the new power-generating system to operate in this fashion. To the right is seen a copper boiler which is made with vertical tubes so as to secure maximum heating results from the gas burner seen at the extreme right. In the center foreground there is seen a small turbine, which is fed with vapor from the boiler by the upper pipe line, furnished with a valve at one end and a pressure gage at the other. The exhaust from the turbine goes into the water condenser, which is located back of the turbine, and the condensed liquid runs into the small well, seen to the left of the turbine, from which it is pumped back again into the boiler by means of a small pump connected to the shaft of the turbine, located immediately in front of it and run by it.

One gallon of the liquid was filled into the boiler and the heat was turned on. Within a period of six minutes the pressure gage indicated a pressure of 100 pounds per square inch. The valve on the turbine feed line was then opened and the turbine immediately started operating. It eventually reached a speed of 8000 revolutions per minute. This test was to demonstrate the fact that the new liquid will generate a vapor which will run a turbine in a closed system, so that no additional liquid need be added to the same during its operation. The apparatus worked perfectly. The vapors were easily condensed and the condensed liquor was pumped back into the boiler. There did not seem to be any difficulty experienced in the running of the apparatus.

The next test was for the purpose of demonstrating the superiority of the new power medium over steam. The apparatus used is shown in our second view. The arrangement is very simple. It consists of two boilers, built identically alike, with the same dimensions, and connected by a small pipe to a small reciprocating engine. The pipe is controlled by a three-way valve, so that the vapors from either of the boilers may be passed through the engine.

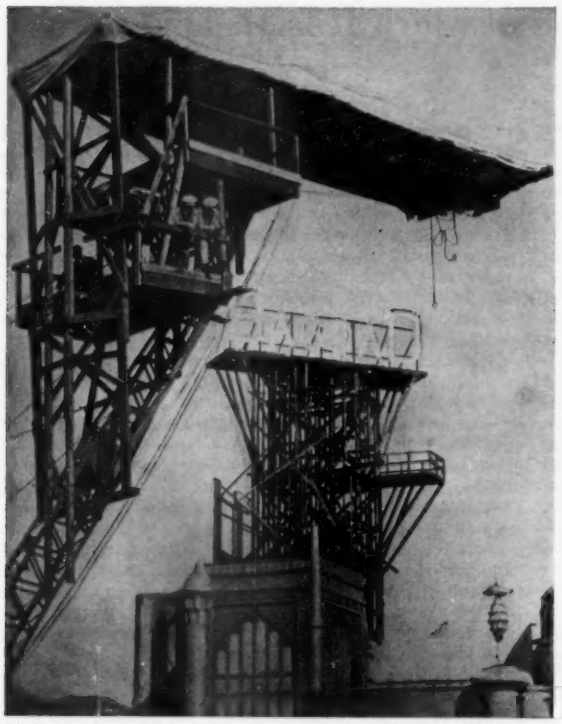


Model steam engine and two boilers, one using the new liquid and the other the usual water, so that either the new vapor or the steam power can be applied to the engine

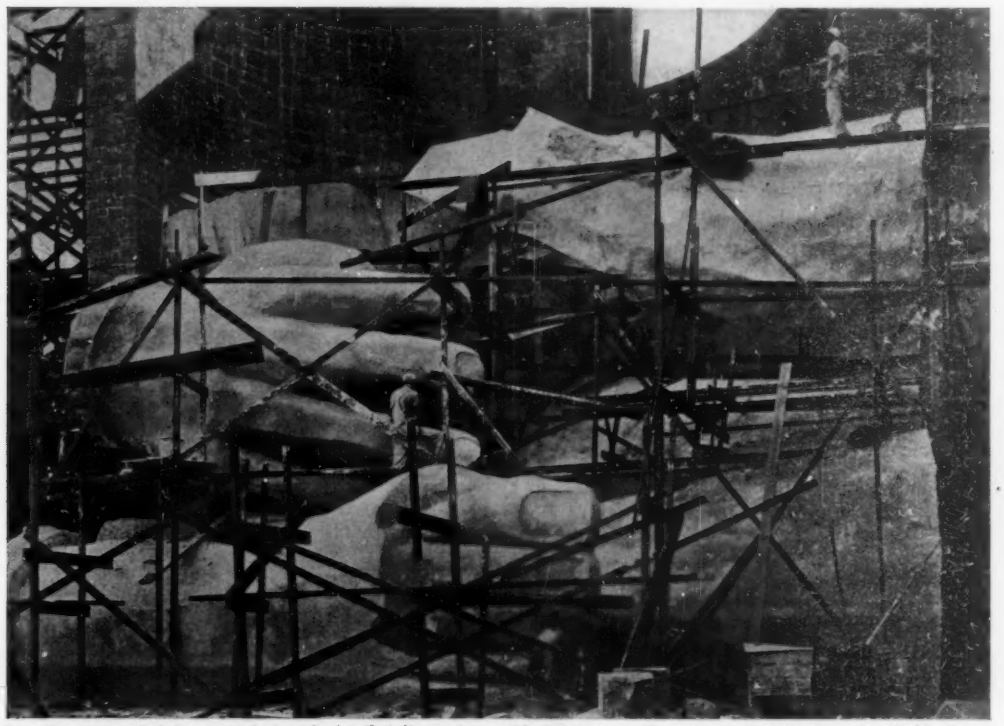
The test was first made with water, both boilers being filled to the same level with the two liquids, water in the left boiler and the new liquid in the one on the right. The heat was supplied by the gas burner seen in the figures. It took sixteen minutes for the water to be heated up to such a point that the gage registered a pressure of twenty pounds per square inch. The three-way valve was then opened and the steam was allowed to flow into the steam cylinder of the engine which immediately started running. It was run for about ten minutes or more to allow it a chance to develop maximum power and then weights were added to the brake beam that is seen in the figure. The ratio of lever arms on the brake beam was four to one, so that the actual force exerted on the flywheel shaft was four times the weight on the pan of the beam. The steam pressure dropped almost immediately to zero after the engine started operating and remained there during the experiment. Weights were then added to the pan and when three of them, all equal in weight, had been placed on it, the engine stopped running.

The boiler on the right was then heated with the same burner, the flow of gas through it being maintained absolutely constant. It took exactly two and

(Continued on page 216)

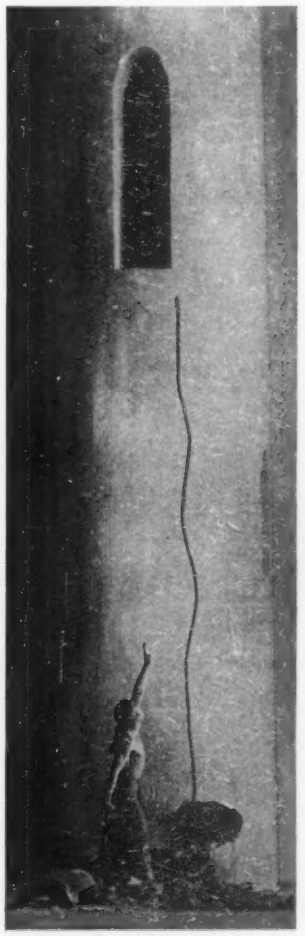


Highest camera-stand ever built, perched on top of a 90-foot steel boom and used by cameramen and director during the filming of the Feast of Bagdad. Note the sunshades overhead, and the two platforms, one above the other. This type of platform permits of "shooting" scenes from any height and any angle within the limitations



The film story called for an idol of such size that it was impossible to construct it on the studio lot. In spite of this, however, it was imperative that the idol be shown in the picture. The technical department did the "impossible" by building the idol in sections, as shown in this view, each section being photographed separately and then assembled on the film. This ingenious bit of trick photography was accomplished by using a series of mats to cover certain portions of the film, while others were recording a section of the idol and involved that remarkable precision of modern cinematography

The make-believe City of Bagdad about the year 800 A. D. Experimental work with models convinced the producers that the surfaces used in the Bagdadian scenes of this photoplay should be plain, simple and massive. Most of the building walls were constructed of plaster with a ribbed or corduroy finish calculated to diffuse the crystalline brilliance of sunlight concentrated on it by huge tin reflectors, in a manner which would give a textile sheen. The finish was painted in varying tones of gray, silver, and in several instances, dun color. The shade deepened gradually as it ascended, thereby taking the weight of the buildings off the ground and suspending it in the clouds, artistically speaking. A glistening, glossy black was chosen for the floors, because it reflects the exact color of light thrown upon it. Here again we see the novel camera-stand which saved much time and trouble in filming the action



Douglas Fairbanks sends his magic rope into action. "The Thief of Bagdad" contains a taste of the modernistic and impressionistic schools, which must prove a delightful surprise

MAKING THE PHOTOPLAY UNREAL: HOW SCIENCE AND ART HAVE PRODUCED A SCREEN FANTASY

The Gelatine You Eat

How the Pure Food Laws Restrict the Raw Materials of which It Is Made

By A. G. Ingalls

GELATINE, that exquisite confection that melts away in the mouth into cool, fragrant nothingness is assimilated by the stomach quicker and with less effort than any known food. Hospital physicians, as well as hospital patients are so well aware of this fact that it finds a large place in the diet of the sick. That those who are well love it almost goes without saying. When the appetite pails and we seem to crave nothing at all, gelatine by some magic slips down the throat and leaves a sense of fullness without a sense of qualm. In food value it is almost equal to sugar and like it it supplies heat and energy to the body without burdening the digestion with proteins. Gelatine is not only a welcome desert but it is food.

The quaint old Dutch city of Delft, noted for rare porcelains is also noted for its manufactures of gelatine. To its quays come tramp ships laden with cargoes of bones from India; while other ships carry to the United States large consignments of gelatine that has been made from these bones. More gelatine is used by the United States than all the rest of the world put together, for we are the greatest consumers of ice cream in the world and it is a fact that over 90 per cent of the commercial ice cream made in this country contains gelatine. The next time you eat ice cream remember that one of its important constituents probably came from India and was derived from animal bones.

Bones from India? Bones of what? Not old bones bought of the ragpickers! No. Gelatine of the kind that is made in the Netherlands is made from the carefully selected shinbones of the East Indian water buffalo. This is not the buffalo that once roamed the "Great American Desert" in seemingly inexhaustible numbers. It is not even a wild animal. In India the water buffalo takes the place of the horse. It is the principal farm animal. It is domesticated. But the Hindu does not eat water buffalo—any more than he eats beef. Buddhism forbids either the eating or the killing of all animals and it is because of this religious taboo that ninety thousand tons of sun-bleached and degreased buffalo bones are available annually for the manufacture of gelatine, as well as of bone buttons and Japanese ivory carvings.

One of the chemical laboratories in a Dutch gelatine manufactory, where gelatines are tested

Gelatine is found in the bones of most animals, as well as in certain of their tissues and membranes, and its easy availability derives from the fortunate fact that while insoluble in cold water, it is easily soluble in hot. When cooled, it forms a jelly which is able to include within its mass from five to ten times its own weight in water.

In a chemical sense, ignoring the highly important considerations of freedom from harmful bacteria and certain chemicals introduced in manufacture, common glue is not greatly different from gelatine. However, little pains need be taken to insure that glue should be germ-free. Its essential quality is its stickiness. As long as it is sufficiently sticky it makes little difference what part of the animal, nor for that matter, what animal, it comes from. Glue is often decidedly offensive to the nostrils because there is no particular need to keep out the bacteria that produce decay. Almost any pure food will decay—unless steps are taken to prevent it. But instead of saying that gelatine is a sort of glorified glue, let us say that glue is often a debased and unclean gelatine. Many of the manufacturers of gelatine also make glue, generally in separate factories or in separated parts of the same general factory group. By their knowledge and equipment they are better able to make it than others, but they are decidedly careful about keeping these two branches of manufacture unscrambled. Otherwise the pure food laws would reach out for them in short order. Gelatine imported from the Netherlands is made from clean raw material and the processes take place in as clean an environment as only the scrupulously, insistently clean Dutch people know how to maintain. The old joke about the Dutch housewives getting down on their knees and scrubbing the very sidewalks is based on fact—they do it. It is difficult to see how the husbands of these everscouring, irrepressibly energetic Dutch women can derive any solid comfort or repose from their home life.

The full process of making gelatine requires from four to six weeks of continuous day and night work. First, the sun-bleached, degreased bones are treated in a vat for several days in a weak solution of muriatic acid. Gradually the mineral matter in them, such as calcium or lime phosphate, and the carbonates of calcium and magnesium are dissolved out, leaving behind the material which contains the gelatine in its unfinished condition. An experiment which is analogous to this process may be tried out by any one by placing a bone from the table in a weak solution of hydrochloric acid and leaving it several days. The instructive part of the experiment consists in the discovery, made after the solid matter is gone and a soft glutinous core is left, that bone contains so much within itself that is not bone. As much as 60 per cent of the volume of some bones consists of gelatine.

The residue that remains in the vat after the treatment with acid is next washed many times with pure filtered water. The purpose of this is to remove practically all of the chemical compounds formed when the acid unites with the minerals forming the rigid part of the bone. Just as in careful chemical work, clean, filtered water is used for this purpose.

Following this the stock is treated many times with lime water, removing any fats that may be present, and at the same time loosening the fibers and releasing the gelatine. Then the stock undergoes several washings and goes to the vat for the next process, which is the boiling.

The purpose of the boiling is simply to extract the gelatine, since it is soluble in hot but not in cold water. After the first boiling most of the gelatine rises to the top, where it is drawn off. Several successive boilings at increasing temperatures (necessitating that the liquid be contained in a tight boiler in order that higher temperatures may be arrived at) free practically all of the gelatine. Of course, the strongest gelatine comes off with the first boiling, just as by far the most of the coffee is extracted from the coffee grounds with the first water.

The gelatine which has been drawn off is now run through pipelines into a specially cooled room where the thin, hot liquid soon cools into a jelly-like mass. It is then cut up into sheets and placed on nets over wooden frames which are conveyed to a long alley through which a strong current of hot, dry air is blown. The purpose of this is to remove the moisture in the sheets, and the greater part of it is removed there. This puts them in condition to be ground up, ready to be packed in the common granulated form for use. The long process of manufacture is now completed.

But before it is put out on the market the gelatine must be tested and graded. Each run is tested independently by several chemists, and these tests are of two general kinds. One has in view the determination of the number of bacteria, if any, present; the other, the percentage of unessential chemicals contained. In both these regards the gelatine must conform to the rigid requirements of the pure food laws of the United States, as well as the often more rigid requirements of individual States such as, for instance, Pennsylvania and North Dakota. It is claimed that the gelatine imported from the Netherlands is higher in purity than the requirements of the American pure food laws demand.

Gelatine is without doubt known by most of us as a dessert. But there are other outlets for it that are still more important. Most of it is used in the manufacture of ice cream, in the United States than for any other purpose, this immense industry accounting for 8,000,000 pounds of gelatine annually. This amounts to about double the quantity consumed as a table jelly. The American candy industry uses another three million pounds every year.

In addition to these uses, gelatine is found in a large and varied list of commercial products. A few of these are pharmaceutical products such as capsules and coated pills prescribed by the physician. Not a photograph could be taken, not a motion picture shown without gelatine, although the gelatines used to coat the photographic films need not be as pure as those which regale us after a hearty dinner. The standard set by the Federal food laws for food gelatines permits, out of one million parts (not one thousand) only 30 parts of copper; 100 of zinc; 20 of lead; 350 of sulfur dioxide; and 1.4 of arsenious oxide, or less than one part in 700,000 of the last named. But many table gelatines are now made so carefully that they contain only one-fiftieth of these mineral allowances. Thus they are fifty times as pure as Uncle Sam requires them to be.

Relativity and Modern Physics

GENERAL attention has been drawn to the great number of volumes in which an attempt is made to present the elements of Einstein's theory to the popular reader. At the same time there has been a considerable number of books offered, of more real scientific value, dealing with one aspect or another of relativity. There has not, however, been a serious book upon relativity, for the serious student, which made a minimum demand in the way of technical requirements. Dr. George D. Birkhoff has now filled this gap in the literature with a book entitled "Relativity and Modern Physics." After dealing briefly with the classical physics, the book introduces its reader to the space-time idea, develops this quite extensively, and proceeds to the dynamics of a linear set of particles. Vectors and tensors in two dimensions are discussed, and tensor analysis developed sufficiently for the purposes in hand. By way of a chapter on gravitation in two-dimensional space-time we pass on to the four-dimensional continuum, and come to a climax in two chapters which show the bearing of the whole subject of relativity upon dynamics, electricity, and the theories of matter. The book, Dr. Birkhoff tells us in the preface, aims at definite advances in the theory and a novel presentation of the subject; and we think it achieves both aims. The book should be of value not alone as a text for an undergraduate course in mathematics and physics in which relativity is to be dealt with—something to which our colleges must soon come; but equally to any person whose intellectual wants and educational equipment match, approximately, those of the upper layer of undergraduates. It is published by the Harvard University Press.

Geyser Heat for Iceland's Homes

IN Reykjavik plans are being made to make use of the neighboring geysers for heating the city. The geysers are situated within a mile of the city and have long been used for laundry purposes. Now it is planned to make use of this never-failing source of heat by piping the water into the city in wooden pipes.

The Continuous-Motion Clock That Does Not Tick

A CLOCK in which the pendulum does nothing and yet regulates the timekeeping with great accuracy would seem an impossibility, but this epoch-marking development has lately become an accomplished fact. In order to appreciate the importance of the new movement, which has been invented by Mr. Alexander Steuart, a clockmaker and electrician of Edinburgh, it is necessary to recall the faults of the mechanism by which pendulums have regulated clocks hitherto.

Almost everyone will have watched a pendulum swinging in a clock, while the escapement to which it is connected allows the escape wheel to move round one tooth at each swing. But between ticks what are known as the pallets of the escapement are sliding on the escape-wheel teeth, causing slight friction, and unless the finest workmanship has been exercised in the making of the parts the clock will not be an accurate time-keeper. Again, wear affects the regulation of the clock, as does also the lubrication of the minute sliding surfaces.

Another drawback to the ordinary pendulum movement for certain purposes is that the second hand moves in jerks instead of continuously. For the ordinary timekeeper this feature is of no consequence, but should it be necessary to record time in fractions of a second, continuous motion is essential. This is employed in clock mechanisms for moving large astronomical telescopes and those which drive revolving drums for some instruments in which the measurement of time by fractions of a second is required. But the motion does not remain accurate for long owing to the lack of effective regulation.

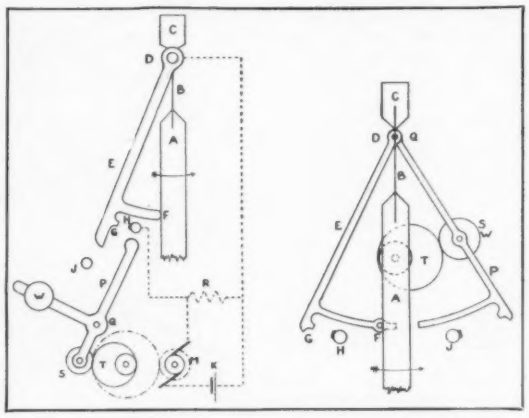
Mr. Steuart's pendulum movement overcomes both the above-mentioned drawbacks, being frictionless and continuous, while time-keeping within half a second a week of dead accuracy is easily reached. Referring to the left-hand drawing, which shows the movement diagrammatically, *A* is the upper end of the pendulum, which is suspended by the spring *B*. What is called a gravity arm *E* is pivoted at *D*, which coincides with the bending point of the spring when the pendulum swings. *M* represents a tiny electric motor, which drives the eccentric *T* through the gear wheels indicated by dotted circles. The eccentric *T*, as it turns, rocks the lever *P* through the roller *S*. The weight *W* on a cross-arm of the lever keeps the roller always pressing against the eccentric.

We will assume the pendulum to be in the middle of its swing from left to right, the gravity arm by its weight applied at *F* giving enough impulse to keep the pendulum swinging. When the pendulum has swung a little further to the right, the contact *G* strikes the fixed contact *H* and allows electric current to flow through the motor from the battery *K*, through the pivot *D* and the gravity arm, the circuit being shown by dotted lines. In the meantime the eccentric *T* has moved forward allowing the roller *S* to swing to the right under the influence of the weight *W*. *P* therefore swings to the left and engages with the gravity arm, raising it clear of the pendulum on its return swing, until at the end of the movement the gravity arm is lowered on to the pendulum by the eccentric pushing *P* over to the right, and another impulse is given.

The motor naturally runs faster when current is flowing through it, that is, when *G* and *H* are in contact. It is kept running between contacts by a fly-wheel and by a reduced amount of current which flows, through the resistance *R*. The longer the current flows, therefore, the faster will the motor run and drive the clock. But the faster it runs the sooner will the eccentric cause the arm *P* to move the gravity arm to the left and so break the contact and reduce the current. This shortens the time that the full current flows, and therefore lessens the speed of the motor. In fact, the combination regulates itself.

In actual practice the gravity arm and the lever *P* may be fulcrumed on the same pivot, marked *D* and *Q* in the right-hand drawing, while the eccentric is differently placed, but the cycle of operations is the same as described.

With the invention is attained a continuous motion suitable for driving astronomical telescopes, while time-charts of recording instruments driven by it can be divided into fractions of a second. Electric bell signals can be made at any intervals of time without disturbing the pendulum. The driving power is not limited, although that required even for large turret clocks is negligible. The heaviest clock can be regulated by a comparatively small pendulum. Extra friction in the form of snow on the hands of a turret clock has no effect other than to cause a temporary microscopic lag of clock time and longer periods of contact. Variations in the voltage of the driving current do not alter the average speed of the motor. Even missed or faulty contacts cause only slight temporary incorrectness. The performance is almost independent of fine workmanship. And, finally, the clock is silent.

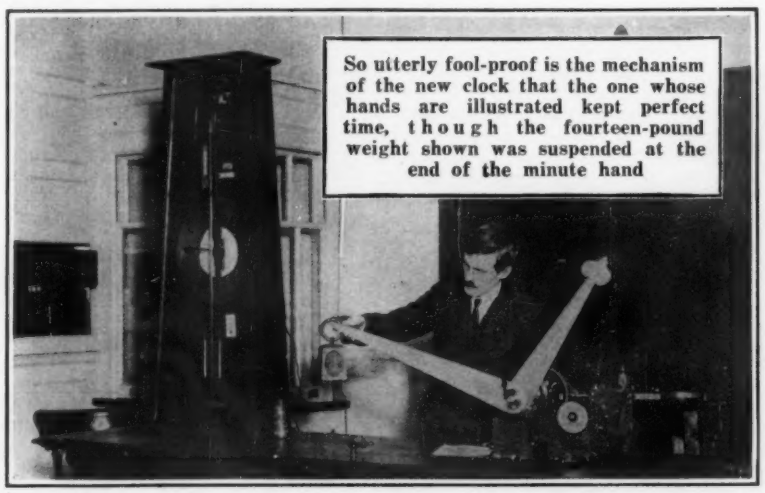


Left: Diagrammatic representation of the theory of the new clock. *Right:* Diagram of an actual installation

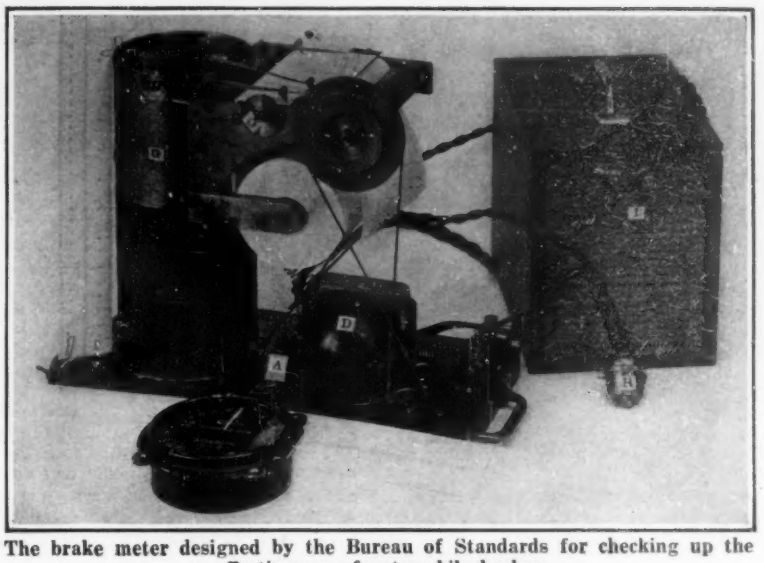
The electric clock that moves smoothly and keeps perfect time

A clock with a 20-pound pendulum working on this system keeps time within half a second per week. Greater accuracy than this is impossible unless the pendulum be enclosed in an air-tight case. Incidentally, it is quite possible to place the pendulum in a vacuum case deep underground where it would be free from variations of temperature, as the clock itself may be at a distance.

The turret clock of which the hands are illustrated is driven by a 1/25-horsepower motor controlled by an 8-ounce pendulum. Even the 14-pound weight shown hung to the minute hand had no effect; in fact, the clock has kept accurate time with a 56-pound weight hung on the minute hand one foot out from the center. The mechanism of this clock is exceedingly simple, consisting as it does of triple-reduction worm gear between the motor and the minute hand. It is believed that Mr. Steuart's movement is the most important development in clockmaking which has taken place in modern times.



So utterly fool-proof is the mechanism of the new clock that the one whose hands are illustrated kept perfect time, though the fourteen-pound weight shown was suspended at the end of the minute hand



The brake meter designed by the Bureau of Standards for checking up the effectiveness of automobile brakes

To Measure the Stopping Power of Automobile Brakes

A DECELEROMETER for making a graphic record of the behavior of an automobile when the brakes are applied has been invented at the Bureau of Standards and is being used for making tests of the effectiveness of brakes under various conditions. The instrument consists essentially of a heavy weight mounted on the upper end of a stiff spring, with a pen and multiplying mechanism for recording the movement of the weight on a strip of paper. As the brakes are applied the inertia of the weight causes it to swing forward, the extent of the motion being proportional to the rate at which the car is losing speed. The whole apparatus fits into a small wooden case and is placed on the floor of the car.

The curves drawn indicate the force applied by the brakes to stop the car, and show how this force varies throughout the period in which the car is being stopped. In one of these curves a distinct break near the center was found, at which point the braking force had dropped to less than half its normal value. On going back over the road the observers found a grease spot which the car had gone over at the time that part of the curve was being made.

In the accompanying photograph, *A* represents the timer, *B* the weight, *C* the pulley for the wire connecting the timer to the timing pen, *D* the motor to drive the paper, *E* the motor to drive the timer, *G* the case for the weight and spring, *H* the switch, and *I* the wooden case that encloses the whole apparatus.

Another pen, operated by a motor to which the tachometer is attached, puts on the chart a scale of time; while still another pen permits of recording the time at which the driver is given the signal to stop. It is found that an appreciable time interval elapses between the giving of this signal and the commencement of the braking action, the interval varying with the car, the driver, and the driver's occupation at the time the signal was given. The average of a large number of tests with foot brakes was four-tenths of a second, during which time the car would have gone 12 feet if traveling at a speed of 20 miles an hour. The time intervals varied from 0.15 to 0.6 seconds. Considerable delay was found to occur if the driver was shifting gears at the time the signal was given, or if he had his foot on the gas at the time. The delay was much greater with the hand brake than with the foot brake.

Gets Russian Metric Rule

THE Metric Association, of which Dr. George F. Kunz is President, announced recently that it had received a copy of the decree by which the Russian Government now permits the use of only metric weights and measures. "The new Russian laws covering weights and measures," explained Howard Richards, Secretary of the Metric Association, "throws new light on the relations between England and Russia. Heretofore the British quart, gallon and other liquid measures, which differ by more than 20 per cent from the corresponding measures in the United States, have been used to a limited extent in Russia. Hereafter any dealings the British have with Russia must be on the metric basis."

The Problem of Mine Fires

A NEW and determined effort to find a means of extinguishing the destructive fires that have been raging for years in anthracite mines of Pennsylvania is now being launched, impelled by a number of new fires and the expansion of several old ones to the point where the emission of gases is beginning to constitute a threat to human life and habitations.

For half a century the best engineers in the employ of the great coal producing companies, and the scientists in the pay of the State of Pennsylvania and of the Federal Government, have been trying in vain to find a method of extinguishing these fires. To the engineer who is not familiar with the vast extent of anthracite mine operations, and even to the layman with only a high school knowledge of physics, the problem is superficially a simple one. It would seem that it should be easy either to flood the burning section of the mine, or to seal up all openings and suffocate the combustion by a lack of oxygen. Both methods have been tried, but with indifferent and temporary success for reasons that will be explained.

It has been suggested that all the old methods of attempting to control mine fires fail because they depend on time for their success. The newest plan is to attack the blaze directly by an element that it is believed can be forced right up to the fire. In addition to the gases thrown off by the burning coal, it is proposed to mix some of the familiar chemicals discovered in recent years and which have a definite smothering effect. All but two of the openings to a burning mine will be sealed, under this plan. One of these openings will be used to draw out the gases by fans. A tank or compressor will be set up and the gas, mixed with the smothering chemicals, will then be pumped back into the mine under pressure.

The engineers believe a gas can be prepared which will permeate whatever air pockets may be left in the mine to feed the fire, and will still be heavy enough, particularly since it will be under pressure, to stop any undiscovered air leaks. The air pockets and the air leaks combine to interfere with the operation of both old methods of fighting mine fires. A seam of anthracite, it is generally known, nearly always lies at an angle. In workings of any magnitude this seam will undulate at some point or other. When the mine is flooded the undulations create air traps so that the water cannot reach the fire.

Sometimes one company will be operating on the upper end of a seam or slope, and another company on the lower. If a fire starts in the upper mine water cannot be used to any extent without the danger of flooding the lower. The great shortcoming of the sealing plan is found in the immense expanse of anthracite workings. No one who has not been at least over the hills of the three great anthracite regions of Pennsylvania to view the countless breakers rearing their ugly heads can realize the extent of the catacombs beneath them. Some of the larger companies have been at tremendous expense to prepare maps which they believe to be complete, showing every shaft and chamber of the diggings. But it is not uncommon for them to find a forgotten drift, perhaps with the underground entrance hidden by crushed rock or slate.

When a mine is sealed by the plan of concrete walls at all known openings surrounding a fire area, and there is no diminution in the havoc, the operators sometimes dig trenches around the fire area and fill them with clay or even concrete. The difficulty of the problem is perhaps best emphasized by this. No one can tell definitely in which direction a mine fire will spread. The direction of the seam at the last cutting may be known. But there is nothing to show that it does not dip or rise just beyond that point, and so far no method has been devised to get anywhere near a mine fire, because of the intense heat and the smoke.

Mine experts find that the popular opinion of mine fires is far from the actuality. It is generally thought, for instance, that millions of tons of coal are consumed annually in the dozen or more fires now raging in the anthracite regions. As a matter of fact the actual coal consumption is relatively small. The damage done is mainly by the smoke that shuts off valuable workings and makes it impossible for the operators to take out any coal. Thus sealing is resorted to not only to starve out the fire but also to keep the smoke out of adjoining operations.. And here the uncertainty of the old methods becomes increasingly apparent. Sealing halts the fire only in known, mapped chambers. Fire in a mine never burns directly on the face of the seam; that is, it will not consume the solid vein. It is the loose coal that burns. But the heat from this causes a constant contraction and consequent cracking of overhead strata. The pressure on the face of the seam breaks off more coal, and this adds fuel to the flame. An anthracite mine fire might be likened to a perfect automatic stoker with an unlimited supply of fuel.

With seals all in place the fire may eat its way slowly, during a period of years, through a seam until it gets into adjoining workings. Even if the fire area has been surrounded by trenches it may cut under the fire wall, or go through it. This phase of fire spread is somewhat of a mystery. It happens, but no one knows exactly how. It is a matter of record in several great mine fires, notably in the Summit Hill mine in Carbon County, where the fire has been raging for fifty years. A trench 250 feet deep was cut around this fire area. It was four feet wide. Wet mud was sluiced into this trench some years ago. But the fire is now burning beyond the mud wall. It is estimated that several million dollars have been expended in the effort to halt this particular fire. The vein is one of the richest known, being sixty feet thick.

That a fortune awaits the engineer who can develop a quick and certain method of extinguishing anthracite mine fires goes without saying. The time when it was cheaper to abandon a mine, flood it and let it burn because there was just as much coal on the adjoining ridge, has passed. Coal in tremendous quantities is still there, but it is closely held, royalties are high and expenses of operation are greatly increased. The larger operators particularly find their profits in working every available drift and they are determined to find a means of stamping out the fires. All sorts of efforts have been made to devise oxygen helmets that will permit adventurous miners, careless of life, to venture into the miles of tunnels filled with poisonous smoke. There has been talk of asbestos suits in which these daring workers might penetrate through the intense heat, but nothing practical has ever come of either plan.

Theoretical experts have been insisting for some years that the answer can be furnished by the chemist, but heretofore the mining experts have been able to find the flaw in most of the plans suggested. The same experts hold that there are many problems to be solved in connection with the new plan before it will work, but they are said to be agreed that it is the most feasible suggestion so far made not only to deprive the fire of its essential oxygen, but to supply it with a suffocating chemical agency, part of which is the very gas that the fire has thrown off. A problem now being studied is to make this heavy enough so that it will seek the lower levels by its own weight, displacing the air and gradually choking off every vestige of fire.

Civilization and the Microbe

BACTERIA, germs or microbes, are so small that fifteen millions of millions of them would scarcely balance an ounce weight. Some of them kill us, yet we cannot possibly do without them. In fact, without them we should all die far sooner than we would with them. They seem to have evolved along with us and the other animals, and now we are interdependent, at least with many kinds of bacteria.

The many kinds of bacteria fall into three groups, according to shape. The spherical ones are called *cocci;* the rod-shaped ones, *bacilli;* the corkscrew-like ones, *spirilla*. They are all colorless. An averaged-sized bacillus, that which causes typhoid fever, for instance, measures about one-twelve-thousandth of an inch in length. That of "flu" is about half that length, according to Arthur Isaac Kendall, Dean of Northwestern University, Chicago, whose new work, "Civilization and the Microbe" was written as a popular exposition of the activities of the microbe. Here we are told that a bacterial individual grows by parturition. First, it elongates somewhat beyond the normal size. Then a slight constriction appears in the middle, and becoming deeper and deeper, the individual divides into two exactly similar cells of equal size. All this takes little time, for under favorable circumstances this newly generated individual will have given birth to a third generation within fifteen minutes.

Many bacteria can row. For oars they have *flagella*, little "whips" whose diameter is about one-two-hundred-and fifty thousandth of an inch, and by wiggling these in a manner quite like the motion of oars they are able to progress through a liquid at the alarming rate of four inches per hour—about as many inches per hour as a man can row a boat in miles.

When living conditions do not suit them, in case of heat, or extreme dryness or cold, microbes have the power to "hibernate." They form *spores* whose function is to increase the resistance of the residual germ substance contained within them so that they may survive not only heat and drought, but some chemicals and long duration of time. Some spores may be kept in boiling water for several hours without killing them, while bacilli of anthrax which have been kept in dry storage since 35 years seem to be as good as new. A mouse under whose skin they were injected died just as quickly as another mouse that received the same treatment from the same batch of anthrax germs 35 years ago.

But not all microbes have the power to form the spores which carry them over hard spells, and it is fortunate for us that they have not. It is due to this fact that we are able to pasteurize milk simply by heating it to 140 degrees Fahrenheit, retaining it at that temperature during twenty minutes and then cooling it rapidly to 40 degrees Fahrenheit. While this low heat does not kill spore-forming microbes it does kill or seriously weaken those which are pathogenic to man.

The freezing of bacteria in ice kills off most of them. This is not due to the direct effects of cold, but actually to the crushing done by expanding ice crystals. A few generally escape, but repeated refreezing further decimates their numbers. Yet so great are their reproductive powers that it is by no means safe to assume that ice, because it is ice, is germ-free. Given a few survivers the whole community of microbes can regenerate itself in short order, provided there is food—and there is plenty of germ food in the human body.

One very old method of defeating the microbe without actually killing him is to use salt. That mineral has a powerful affinity for water—it wants water and will go to all sorts of ends to get it; thawing ice, for instance. Salt acts as a preservative simply by blotting up the water that the germ has in his system, just as we have water in ours. He either dries up and ceases to grow and sub-divide, or is actually extinguished. Pickling or "corning," a method used by past generations for preserving food, depended on a similar affinity of saltpeter for water. In this manner some Egyptian mummies were preserved. Sugar has a very similar effect, and honey may be similarly used as a preservative.

Bacteria do not themselves injure us. It is the poisons they manufacture and secrete which give us disease and often kill us. These poisons are called "toxins." But the minute the body is invaded by these germ-produced toxins it sets to work preparing its own anti-toxins. There is war. If the body is in good condition it will probably be able to make enough counterpoison to whip the toxins. But if there is too large a dose of germs, or if a relatively small dose finds us weak and "run down," the germs win—unless a dose of anti-toxin prepared in some other body, generally that of a horse, rushes up reserves and saves the day.

Modern sewage disposal depends on bacteria. Here is a fine illustration of bacteria that are very helpful to man. In sewage disposal plants the filter beds consist essentially of layers of sand, but it is not the sand itself that does the chief work of purification. On top of the layer of sand there is kept a thin layer of microbes, a living carpet through which the pathogenic bacteria must pass, if they are to go on living. The water which passes the layer of philanthropic microbes is so pure, not merely in appearance but in the sense of freedom from germs, that one of the regular show-off acts of employes of sewage disposal plants is to drink the water as it issues from the filter beds.

Ordinarily we are unaware of the presence in and on our body of many kinds of microbes, but they are always there. Generally our skin is so intact that they cannot break through it and get into the blood. But if the skin is broken these little opportunists at once seize their chance, enter and begin to establish themselves and multiply. Some bacteria enter the body of man through the air he breathes. This is especially true of those of tuberculosis and "colds" which are often caught as a result of the spray that floats through the air to distances of several feet after those who harbor the germs of these diseases cough or sneeze.

In general, the sum total of microbic participation in life is overwhelmingly on the side of beneficence. The notoriety that attaches to the microbes arises from the interference of a small but extremely formidable group of bacteria whose activities are in opposition to those of man, and the natural outcome of the struggle between mankind and microbe has always favored man.

ONE of the gigantic industrial achievements of the modern state, which often goes unsung while praise is being lavished upon some far less noteworthy item of civilization's structure, is the feeding of a great nation. Without turning our attention at all toward the ways in which this task is accomplished, we present herewith some figures that will show its sheer magnitude.

The people of the United States spend for food $49,000,000 per day—$1,500,000,000 per month, or $18,000,000,000 per year. Nearly one-third of this amount goes for bread, potatoes, fruits, sugar, and other food of vegetable origin. The other two-thirds, plus, is spent for meat, fish, eggs, butter, cheese, lard, milk, etc. In the course of a year, we consume over two and a half billion eggs and nearly ten and a half billion gallons of milk. The eggs consumed in a single day, if combined in a single shell, would make an ellipsoid 36 feet long and 24 feet in its shorter, circular diameter—something beside which even the dinosaur egg of recent fame would shrink into insignificance. And the milk bottle that would hold our daily ration of this vital food would be 385 feet high and 152 feet in diameter.

To some extent, there is duplication between several items of our drawing in which these and other facts connected with our daily food supply are shown graphically. All these figures are got by dividing the year's production into 365 equal portions. But the milk that went into the production of the butter, cheese and ice cream figured independently in the milk production as well. We do not drink, as milk, 115 million quarts per day, or anything like that—if we did, it would mean a quart apiece per day, a direct consumption that is not approached. Our artist has been unable to separate the milk that is consumed direct from that which goes back into the manufacture of other foods, however, so the duplication is unavoidable. We suspect, also, that his lard is included in the poundage of his meat animal, as well as in that of the lard pail: but of this we are not certain. Even allowing for such duplication, however, the showing for our collective daily appetites is a most impressive one, and it must be a source of continual wonder that an agricultural population whose numbers form an ever-dwindling percentage of the total population is able to keep up with the demand for the raw materials from which food is made.

UNCLE SAM'S DAILY MARKET BASKET: ITS CONTENTS, IN DOLLARS AND CENTS AND IN MORE EDIBLE TERMS

Harnessing Arkansas Water-Power

How the Ozark State Plans to Develop the Facilities for Milling its Own Cotton

By R. E. Livingston

DURING the recent agitation resulting from Ford's offer to purchase the Muscle Shoals project from the Government, Roger Babson said that should Ford's offer be refused, the great capitalist should not overlook Arkansas. For this State has a larger percentage of navigable rivers than any State in the Union.

For years Arkansas has been slowly forging her way up as a cotton State, until last year, Government statistics placed her as ranking third in the production of the fleecy staple. Yet Arkansas has practically no cotton mills, aside from overalls factories and twine spinners. The need has been obvious to citizens of the State, but cheap power has been the problem; the spinners of the east are facing the same problem.

When it became known that manufacturers were handicapped because of this fact, and that the manufacture of cotton goods in the United States would practically double if cheap power could be obtained, a movement was started by capitalists of Arkansas to interest eastern capital in helping to harness the 13 navigable rivers of the State.

Engineers and capitalists came from the East to investigate, checking up the fall of the rivers, the amount of cotton produced, and the attitude of manufacturers. They found that 70 per cent of the cotton used in Massachusetts spindles is Arkansas long-staple product. They found that many eastern spinners would gladly build new factories farther south, to save freight and power expense. Contrary to the usual idea prevalent regarding the State, Arkansas is not flat, but hilly, with the exception of the rich river bottoms, and the great rice fields in the southeastern part of the State. Much of drainage and levee-work has commercialized these parts which formerly presented quite a problem.

The entire northern half of the State is mountainous, being in the Ozark chain, while the foot-hills rise abruptly here and there, south, to the Louisiana line. The mountains, abounding in pine, birch and gum, which is shipped north and east in great quantities, offer inducements for utilizing the water-power in the great lumber mills.

The mountains are not of note for their height, there being but two high peaks in the State, Mount Nebo, and Mount Magazine, the latter being the highest peak between the Rockies and the Alleghanies. But their abrupt cliffs and clustering peaks create much fall in the many mountain rivers and bayous.

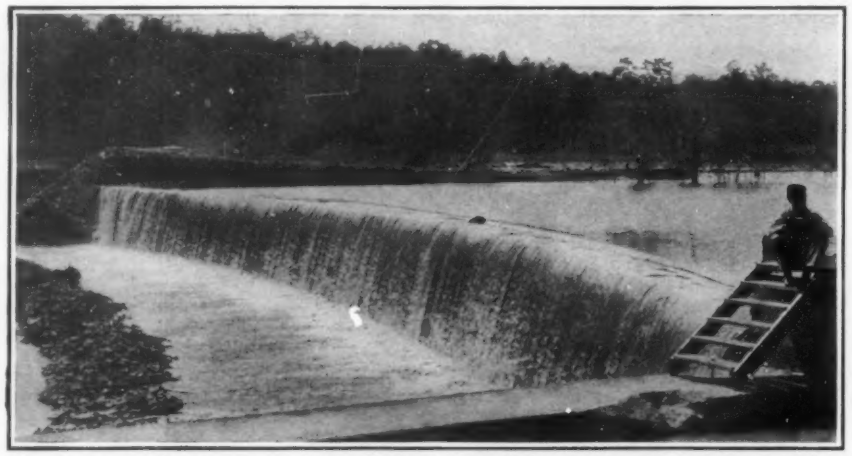
During the past year, projects totaling the expenditure of more than forty million dollars have been launched, some of which are two-thirds finished, others completed and the greatest, The White River project, but barely started.

In the western portion of the State, on Little Mulberry river, dams have been constructed by local capital, to the amount of one million dollars, and the power is used to furnish electric lighting and for local mills.

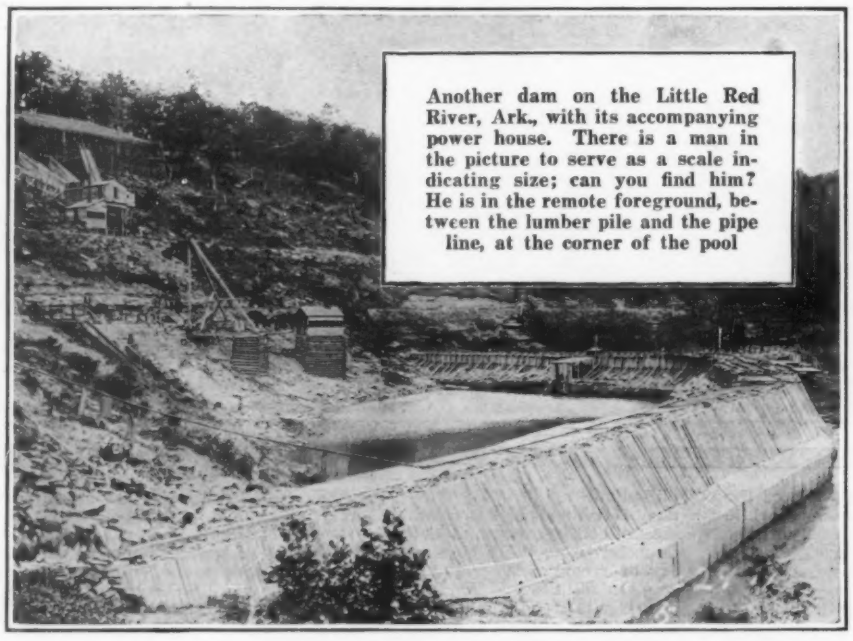
On Illinois Bayou in the midwestern part of the State, a dam has just been rebuilt, which furnishes power for lights and machinery for half a dozen towns and for several coal mines, and compresses. This, too, is owned by State capitalists.

But it is the gigantic White River project which will attract national attention, for this will create more power than the great Keokuk dam, and will be built by the same engineer. Winding around old Round-Top Mountain, about whose nether parts the clouds hang their gauzy draperies, rippling eastward from Big Diamond Cave, creeps Buffalo river and its tributary, Little Buffalo, and on the parent stream the first dam will be constructed. This will cost, with its smaller dams, about twelve million dollars, and will create 35,000 horsepower.

The fall near Buffalo Shoal is 11 feet per mile, more than twice the fall of the mammoth Muscle Shoal. Number 2 dam is to go up near the town of Norfolk, on the North Fork river. This will be a larger work than that of the Buffalo, costing fifteen million dollars, and creating 45,000 horsepower. The waters will form a lake 100 miles long, to be known as Dixie Lake, and extend over the State line into Missouri, and on up to the power-site dam at Lake Taneycomo. Including bays and arms that will be formed along valleys and canyons that lie along White river, this lake will have a shore line of 400 miles. This, it is confidently believed, will be the largest artificial body of water in the world.



One of the smaller dams near Russellville, Ark., which supplies current for a number of towns



Another dam on the Little Red River, Ark., with its accompanying power house. There is a man in the picture to serve as a scale indicating size; can you find him? He is in the remote foreground, between the lumber pile and the pipe line, at the corner of the pool

The largest and final dam of the eight forming the gigantic project will be the Dixie Dam at Cotter, Ark. This will be 250 feet high, cost fifteen million dollars and will have, with the power from the smaller dams, 200,000 horsepower. When completed, this will be one of the largest in the world. The White river basin drains an area of 6200 square miles, with an average annual rainfall of 46 inches. As some of the river bottoms have been subject to overflow in unsual seasons, the holding in check of the water will be a great benefit to land-owners throughout the region.

The final checkings have been gone over, the moneys have been raised, and it now remains for Mr. Hugh Cooper, builder of the Keokuk dam, and head of this project, to push the work to completion. All surveys have been completed and much preliminary work done. Col. Henry Allen, who served on the Panama Canal Commission under President Roosevelt, is chief engineer for the company, assuring the work to be in competent hands. It will require nearly two years in which to complete the project.

Another great engineering feat, nearing completion is the Red River project, which is more than two-thirds finished, and represents an expenditure of five million dollars, creating 30,000 horsepower. This consists of three dams, one at Heber Springs, on Little Red river, the second some 20 miles eastward and the third on Red river proper, near the old college town of Searcy. This region abounds in lumber, cattle, and small fruit raising, which would profit greatly by cheap electric power, being beyond reach of the natural gas fields in the western part of the State. This bit of engineering has a natural rock base, which has been the wonder and pride of the engineers in charge. When finished, this will supply a number of towns with electric power, aside from cotton mills which they hope to locate. This construction has been put forth by local capital.

A smaller project, but a significant one, is that of the dam across Spring river, in the north-central part of the State, near Imboden. This will cost one million dollars and create 5000 horsepower. It is owned locally, and is a part of the great concerted industrial movement of the State.

Turning southward, we come to a two-million dollar project on the Ouachita river near the great oil fields. Much cotton is raised in this portion of the State, and a deep waterway will be constructed, whereby cotton may be floated down by steamer to the Mississippi, and on to New Orleans, thereby gaining a great saving in freight rates. Oil tanks, filled from the local pipe lines, can be put upon barges and sent to the gulf to supply the ocean liners.

At Arkadelphia, where one of the dams will be constructed, are situated some of the largest flour-mills of the south, which will readily utilize much of the new power created. There has been no organized movement among the people of Arkansas for hydraulic power, yet, one project encouraged the launching of another, and the assurance that the great Dixie project was actually to be carried to completion, gave assurance to those interested in the furthering of the great industries of the State.

A Submarine Gold Mine

DIVING for $32,000,000 is a form of sport that should amuse anyone, whether a diver or not, if he were promised one thirty-second of the treasure. During the war the steamship Laurentic, laden with gold to the extent of the sum named was sunk off the coast of Ireland in ninety feet of water by a German submarine. Since 1918 the divers who have been at work on the wreck have brought up the entire amount of gold, in addition to almost $5,000,000 in silver specie. During the first three years of the work only 608 bars of the precious metal were recovered, but after the adoption of the galvanometer in connection with a prod with which contact is made with the bars of gold, 2100 bars each worth from $5000 to $10,000 were recovered, in addition to the silver as stated.

The Size of Stars

ON December 13, 1920, the angular diameter of a star was measured for the first time in history with an apparatus devised by Prof. A. A. Michelson. Hitherto every star had appeared as a mere point of light, and no test had been able to differentiate it from a geometrical point. But on that eventful evening a 20-foot interferometer constructed at the Mt. Wilson Observatory was turned on the star Betelgeuse, and the measurement revealed that this star had a disk one-twentieth of a second of arc in diameter—about the size of a halfpenny 50 miles away. The distance of Betelgeuse is known roughly (unfortunately it cannot be found so accurately as the distances of many stars), so that we can convert this apparent size into approximate actual size. Betelgeuse is not less than 200 million miles in diameter. The orbit of the earth could be placed entirely inside it, as has already been shown pictorially in the columns of the SCIENTIFIC AMERICAN.

"The stars are thus not limited to objects of comparatively small bulk like the sun; there are among them individuals truly gigantic in comparison. We can add another step to the astronomical multiplication table—a million earths make one sun; ten million suns make one Betelgeuse. This is a comparison of volume, not of amount of material. It leaves open the question whether, in order to obtain one of these giants, we should take the material of ten million suns rolled into one, or whether we should take the material of the sun and inflate it to ten million times its present size. There is no doubt that the latter answer is nearer the truth. Betelgeuse contains more matter than the sun (perhaps fifty times as much); but in the main its bulk is due to the diffuseness with which this material is spread out. It is a great balloon of low density, much more tenuous than air, whereas in the sun the material is compressed to a density greater than water.

"Whether the star is one of these balloon-like bodies or whether it is dense like the sun depends on the stage of its life at which we catch it. It is natural to think that the stars gradually condense out of diffuse material, so that they become denser and denser as their life history proceeds. We can now see in the heavens samples of every possible stage in the development of a star. The majority of those seen with the naked eye are in the early diffuse stage; that is not because these young stars are really more numerous, but because their great bulk renders them brighter and more conspicuous. The young diffuse stars—the giant stars—can be studied more advantageously because we understand much more about the properties of matter when it is in the condition of a perfect gas than when it is condensed; although the difficulties of treating a dense star like the sun are not insuperable, we have naturally made the most progress with the easier problem of giant stars."—*Abstract from an article by Prof. A. S. Eddington, F.R.S., in Nature for May 12, 1923.*

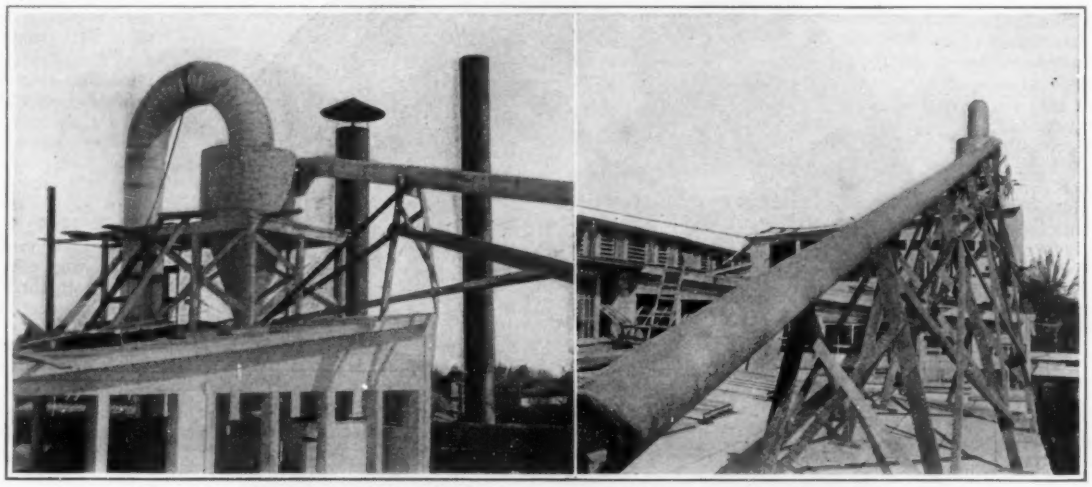
A Novel Gadget for the House-Painter

THE painter of houses has always been puzzled for a way to plant his ladder against the side of the house without making a mark on the freshly laid paint. A way to accomplish this is now offered him in the ingenious ladder-support illustrated. On each upright of the ladder, near the tip, is clamped a curved brace, the other end of which is pointed. These two points, one on either side of the ladder, furnish the bearing points for the ladder. There is not enough pressure to mar seriously the surface of the wood, and the paint, as such, is obviously not affected at all. The two supports between them straddle sufficient width to dodge the widest window nicely, as our picture indicates; and they offer an extraordinarily convenient place from which to suspend the paint pot.

Placing the painter's ladder without marring the fresh paint which he has left above him

The Previousness of Science in India

TO prolong the life of man for thousands of years; to melt precious stones and pearls and give them desired shape, size and color; to enable a man to fast for six months or more without losing health and life; to cause new teeth to grow in the place of fallen teeth—such are some of the benefits to mankind revealed by an ancient library belonging to Dr. Syed Md. Kassim, Jahagirdar, Head of Pasteur Hall, Pathar-gatti, Hyderabad. This library contains rare and valuable ancient books and manuscripts on palmyra leaves, written in almost all the languages of India. Some of them seem to be the works of the hoary Vedic period. In one book is described a kind, although it fails to specify exactly what kind, of wireless telegraphy in which two stone plates are to be prepared and placed at great distance from each other without any wire connection. It is said that communications can be carried thousands of miles by means of these. Jules Verne came too late!



Sugar-blowing system which sucks the sugar up and delivers it to the sirup-mixing room

Sugar Blower System for Cannery

THE accompanying photos show a sugar-blower system which is installed in a cannery. The sugar is emptied into a metal box and is sucked up by a powerful fan and blown through a large pipe into the sirup-room. When sugar passes through the fan and pipes at such a terrific velocity, a small percentage is pulverized. This is very hard to separate from the air and is done by means of a stocking-leg auxiliary to the cyclone separator. Sugar can be carried hundreds of feet in this manner.

Factory Messengers on Tricycles

ONE of the seemingly simple, but actually vexatious, problems which developed when the East Pittsburgh plant of the Westinghouse Electric and Manufacturing Company grew to a floor area of 91 acres on which 30,000 persons found employment, was the distribution of interdepartment mail, including blue prints and bulky files of manufacturing data.

To cover all the essential points required a walk of ten miles; so messengers on foot were altogether too slow for a busy plant, as a trial conclusively demonstrated. Next, six electric trucks were tried, but these proved too much like turning a fire engine loose in a china shop. The trucks were promptly discarded.

Then some genius suggested that boys on roller skates might make the rounds at acceptable speed without creating too much disturbance or being too much in the way. Forty boys were mounted on roller skates and turned loose in the vast buildings. The boys had a glorious time while it lasted.

As a last resort a tricycle with a box about three feet square by a foot and a half deep was procured and a girl was employed to ride it. The problem was solved.

Now a mail-carrying force of 25 girls makes the rounds at frequent intervals, making promptly, unerring delivery of the material so essential to the operation of the plant. The girls are clad in neat blue uniforms. They attend strictly to their business. Their tricycles have solid wheels so the skirts of the riders cannot catch in spokes. The rubber-tired machines are noiseless. The only sound ever heard from the post girls comes from the chime whistle which each carries at her belt to sound as a warning when turning corners.

How inter-departmental mail is delivered in one of Pittsburgh's largest factories

Life in the Ocean Depths

MONOTONY is strikingly characteristic of the eerie deeps, which well-nigh all types of marine animals, from microscopic forms to fishes, have made their abode. There are no seasons — uniform winter, endless night. Yet with a perfectly uncanny adaptability, protoplasm flows as serenely in temperatures sometimes below the freezing point of fresh water as in limpid pools of tropic reefs. There are no bacteria and no living green plants. A ceaseless drizzle of small organisms that have succumbed in the ocean meadows (perhaps miles above) slowly settles like gentle snow on the ocean floor and provides food for multitudes, which in turn fall prey to others, in thousands of cycles.

Deep-sea animals are much more delicately constructed than their shallower-water relatives, many having bodies thoroughly permeable to water. Sedentary forms, such as frail, phosphorescent sea pens, arborescent polyps and tall sea lilies or crinoids, rear themselves above the mud, while quaint spiny crabs, with spindly legs and egg-shell bodies, vie in slimness with the pycnogonids, grotesque "all-legs" neither spiders nor crustaceans. In the branches of these miniature forests of tree-animals dwell thousands of different species of all sorts of types. On and within the ooze are other myriads—bristling sea urchins, sea stars and sea cucumbers, inconceivably delicate shrimps, molluscs and worms.

When we ascend a great mountain the vegetation and animals change with increasing altitudes. Broad belts of approximately equal temperature have a uniform assemblage of plants and animals. So it is when with the long arm of the dredge we follow the bottom into deep water. The lighted zone along shore teems with life unlike that at one hundred fathoms, while at five thousand fathoms still another world is seen, and so on with increasing depth. That temperature is the most important factor seems likely, for at five thousand to one thousand fathoms, for example, off California, are found relatively shallow-water subarctic types.—*Abstract from article by W. K. Fisher in The Scientific Monthly for October, 1923.*

The Heavens in March, 1924

Eclipses and Other Subjects Discussed at the Meeting of the Astronomical Society

By Professor Henry Norris Russell, Ph.D.

THE HOLIDAY season is, by a custom of long standing, packed full of meetings of scientific societies—and discussion now and then arises among their members whether it is more profitable to have one great meeting in some large city, which every one attends, or a number of smaller ones, in various places, each covering a special field. The Astronomical Society this year followed the latter course, with results which more than satisfied those who were present. Meeting at Vassar College—whose busy campus is as empty as any other between Christmas and New Year—the seclusion and the opportunity for continual conference, formal or informal, filled every moment with profit. The list of papers presented was not long—only about 30; but this permitted full discussion, and increased rather than decreased the value of the program. As usual, some of the most eagerly discussed topics were of only technical interest; but, as was to be expected, many of the best were of general interest.

Perhaps the most central topic of interest dealt with eclipses, past and future. Had not the elements been so sadly inclement last September, we should have heard much more; but fortunately one American party—mainly from the Swarthmore and Allegheny Observatories—chose a station far in the interior of Mexico, where, in spite of a torrential rain but a few hours before the obscuration of the sun, good observations were secured.

Professor Miller, the head of this party, told us his story, both in technical form and, later, informally at a public lecture. The latter was illustrated with admirable moving pictures, taken by one of the great commercial concerns, who delegated a camera-man to accompany the expedition from beginning to end. The resulting film gives an admirable idea of the activities of an eclipse expedition—the laborious building of mountings and adjustment of instruments—and ends with excellent pictures of the gradual progress of the partial phases, the corona during totality, and the uncovering of the sun's disk afterwards. It may be cordially recommended to any one interested in astronomy.

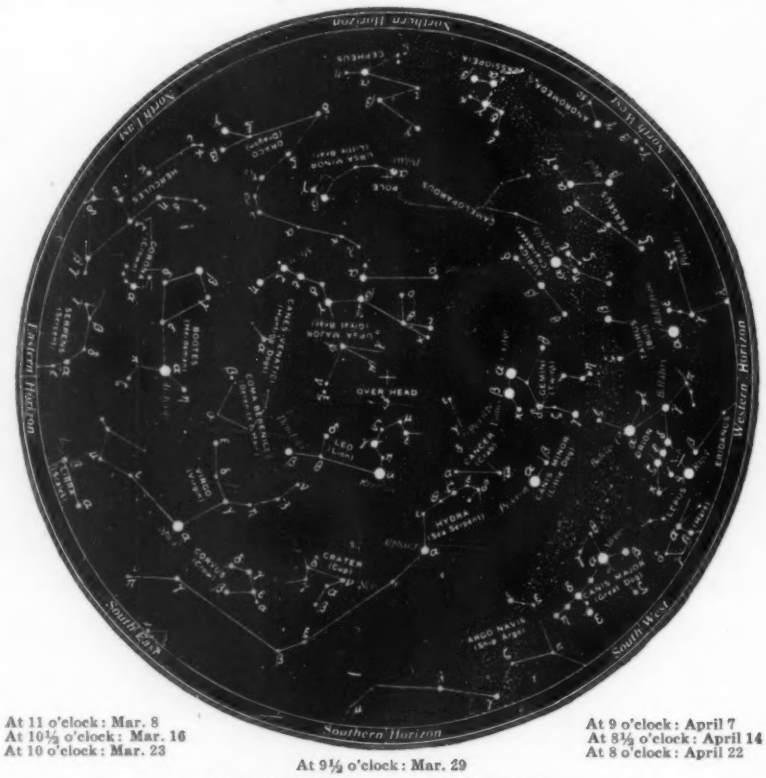
The scientific results included some admirable photographs of the corona, and some starplates—not yet measured—for the Einstein effect. The most noteworthy novelty, however, comes from the spectrogram by Dr. Moore of the Lick Observatory, who accompanied the party, and photographed the spectrum of the corona to detect its rotation. The result was unexpected. Instead of finding the lines in the spectrum of one side of the corona displaced toward the red, and those of the other toward the violet, *both* sides showed strong shift toward the red. That is, the coronal matter, on *both* sides of the sun, is receding from us.

A theoretical explanation lies close at hand. It has long been realized that the force which holds the corona up, and keeps it from falling into the sun, is the pressure of the outgoing solar radiation. If this pressure slightly more than balances gravity the coronal matter will be driven away from the sun. Such an effect was detected by Miller through comparison of photographs of the 1918 eclipse made at different stations, and is now confirmed in this quite different way—the rate of uplift being found, in both cases, to be about 20 miles per second.

The Layman as a Scientist

But the discussion did not end with past eclipses. The coming event of January 20th, 1925, was much in every man's mind. It is rarely that the track of a total solar eclipse covers such accessible and densely settled country. Poughkeepsie itself, Danbury, Ansonia and New Haven, and Montauk Point are almost on the central line; and the zone within which totality occurs extends north as far as Springfield, Mass., and Providence, while its southern limit passes between Wilkes-Barre and Scranton, and right across the backbone of New York City, in the neighborhood of Central Park.

Though the weather prospects are mediocre, the duration of totality of nearly two minutes is long enough to make observations well worth while. Should the sky be propitious every one will have his chance. Not merely the professional astronomer, with his large instruments, and the amateur, with his more modest equipment, but the "man in the street" too can render real service to science. If some one at every street corner along New York's long avenues should stand, watch in hand, and note simply for how many seconds the sun was hidden from him by the moon, we would have the equivalent of a very accurate observation of the moon's position in the heavens; and if similar observations should be undertaken, on a larger scale, all over New England, New York, and northern Pennsylvania and New Jersey, the results would be of correspondingly increased precision. More is likely to be heard of this in the press—and probably in these columns—before many months have passed.



At 11 o'clock: Mar. 8
At 10½ o'clock: Mar. 16
At 10 o'clock: Mar. 23

At 9 o'clock: April 7
At 8½ o'clock: April 14
At 8 o'clock: April 22

At 9½ o'clock: Mar. 29

NIGHT SKY: MARCH AND APRIL

The Variable Star Algol

One other noteworthy paper dealt with eclipses, but eclipses of a very different sort—those of the star Algol by its large but faint companion. Mr. McLaughlin, at the University of Washington, has taken more than 150 spectrograms to determine the orbit of this star, and finds that its velocity curve is very curious. The usual changes are clearly shown—the bright star receding from us before eclipse, and approaching us afterwards; but during the eclipse itself the smooth and orderly progress of this change appears to be interrupted, and the curve shows two regular "humps"—which, however, are far from being objections to the eclipse theory.

Algol is doubtless in rotation as well as in orbital revolution, and both motions are in the same direction. When we observe the star outside eclipse, we get light both from the side which is carried toward us by the rotation and from that which is receding. The light of these different parts of the star gives lines shifted to the violet or the red, as the case may be; but in the combined light of the whole star this produces merely a widening of the lines of the spectrum. When, however, Algol is going into eclipse, the preceding side, which is turning toward us, is hidden, and the other side is clear—so that we get a clear shift of the observed lines toward the red. When Algol is emerging, the other side is obscured, and the shift is toward the violet. The observed peculiarities may thus be explained, to the point of accurate numerical agreement; and the rate of motion of a point on the star's equator, due to its rotation, may be found. If the periods of rotation and of revolution in the orbit are equal (as is probable, but in this particular case not quite certain), we can then calculate the diameters of Algol and its companion, and the masses of both. It thus appears that Algol is of a little more than three times the sun's diameter and a little less than five times its mass, while the companion is almost equal in mass to the sun, but of only one-fiftieth the sun's density, and therefore larger in diameter than Algol itself.

It may be remarked that these calculations depend upon the assumption that the star's disk is equally bright all over. If, like the sun, it is less luminous at the edge, the diameters and masses of the components must be greater though not enormously so.

One more communication, of quite a different sort, may be mentioned. Professor Brower of Yale, since the completion of his great work on the lunar theory, has been devoting his interest largely to the asteroids, and especially to the remarkable group of planets which have periods almost identical with that of Jupiter. Considering first the effects of Jupiter's attraction, he finds that though the asteroid orbits may undergo considerable changes, they will remain of the same general character. For example, a given asteroid will always remain on the same side of Jupiter, as seen from the sun, and at a distance of about sixty degrees from Jupiter. But when the attraction of Saturn too is taken into account, it appears that the combination of certain slow changes in the motion of these two great planets, produced by one another, with certain other changes in the asteroid orbits, will produce further alterations of the latter, which though very slow will continue steadily for an enormous interval of time, and may ultimately lead the little planets into entirely different orbits from those which they occupy at present.

The Heavens

The splendid winter constellations—Orion, Taurus and Canis Major—are now low in the west, with Canis Minor, Gemini and Auriga above them. Perseus is low in the northwest, and Cassiopeia in the north. Draco and Ursa Major are high in the northwest, Virgo and Boötes well up in the east, and Leo high in the south, with Hydra below.

The Planets

Mercury is a morning star before the 22nd and an evening star afterwards, but is too near the sun to be seen. Venus, however, is splendidly placed, an evening star far south of the sun, remaining in sight until 9 P. M. at the beginning of March and 10 P. M. at the close. Mars is in Sagittarius, and is slowly approaching quadrature, but still ranks as a morning star.

Jupiter is in the same part of the sky, about 9 degrees west of Mars on the 1st and 22 degrees on the 31st. He comes into quadrature on the 9th. Saturn is some 45 degrees further west, in Virgo, and comes to the meridian about 2 A. M. in the middle of the month. Uranus is in conjunction with the sun on the 8th, and is invisible this month. Neptune is in Leo, and comes to the meridian around 10 P. M.

The moon is new at 11 A. M. on the 5th, in her first quarter at noon on the 13th, full at 11 P. M. on the 20th, and in her last quarter at 3 P. M. on the 27th. She is nearest the earth on the 23rd, and furthest away on the 11th. During the month she is in conjunction with Mercury on the 4th, Uranus on the 5th, Venus on the 8th, Neptune on the 17th, Saturn on the 23rd, Jupiter on the 26th, and Mars on the 28th. She also eclipses the sun, on the 5th, but this eclipse is only partial at best, and visible only in part of South Africa.

At 4 A. M. on March 20th, the sun crosses the celestial equator, and "spring commences."

Moving Houses One-Third of a Mile on Narrow-Gage Tracks

MOVING houses on narrow-gage tracks is a plan that has been tried out successfully at Hagerstown, Md. Eight of the buildings to be moved were six-room frame houses, and one was a 12-room brick and stucco house. Although the ground was in celery ridges, yet with the use of a road grader a good roadbed was established and then the tracks were laid on narrow-gage ties. Four pony trucks of four wheels each were coupled together from track to track, using a 6 x 10 timber with a truss rod. Then a 14 x 14 timber, 44 ft. long, that rested directly over the king bolts, coupled up each set to suit the length of the building to be moved. Needles 12 in. x 12 in. x 36 ft. were used as carrying timbers.

House placed on railway trucks, ready to be moved, and the sturdy cradle on which the houses were carried on narrow-gage railroad tracks

All of the houses had cellars 6½ ft. deep. By grading down and removing the foundation walls the movers could back the hauling frame under each house. Coming up crosswise to them, it was necessary to give each house one-quarter turn to place it on the platform. Rollers were used for this turning. As it was necessary to use a sharp curve at the new sites, the rear end of the buildings could not land over the lot just right. This was remedied by laying the tracks on past the location, and then the tracks were opened back in the rear and thrown over by crowbars so that each house would land just right when backed up. Wherever it was necessary to turn a house completely around, it was done by using two sides of a "Y," as railroad engines are turned.

The double brick house was rolled on six nests of iron and wood rollers; a 4 x 12 shoe was used, lined with one half steel plate, 7 ft. long. Under each end wall of the building a steel eye-beam, 6 x 20—40 ft. long was placed, and three pieces 12 x 12 were placed up under the joist. Then 12 x 12's, 36 ft. long, and steel eye-beams 5½ x 15—36 ft. long, were used every four feet centers, as cross needles, coming up under with a timber 14 x 14—44 ft. long, under which were placed shoes and nests of rollers.

The track was filled up level with the surface of the rail with 4-inch crossing plank, with third rail laid in the center, making a complete track of 3-ft. gage. The time for truck moving was 10 ft. to the minute; for the rollers, moving 2½ ft. to the minute.

The power for hauling was an improvised capstan, with a ⅝-in. cable 610 ft. long, all anchored to dead men ahead, using snatch blocks around curve, wound up by a horse to an 11-foot sweep.

The frame houses each weighed about 100 tons and the brick about 250 tons. These houses were moved to their new location through a peat marsh, but the work was accomplished with but slight damage.

The "Chemical" Sense

THE mechanism of the senses of smell and taste is apt to be unduly neglected, probably on account of the fact that in civilized man these senses do not play a large part in intellectual processes. But they bring before us some interesting problems as to the nature of receptor organs in general. It will be remembered that the object of such organs is to excite a set of nerve fibers on the incidence of some external agency of such a kind or intensity as to be unable to affect these nerve fibers directly. This is done by the production of some powerfully stimulating agent in the specially developed and specialized receptor mechanism at the terminations of these nerve fibers.

It is difficult to define satisfactorily the difference between taste and smell. If it be said that the former relates to substances in solution, whereas the latter relates to vapors, we are met with the fact that even vapors must be dissolved in the watery layer covering the olfactory cells. Moreover, the presence in fishes of a mechanism which appears to be the same as that of smell in air-breathing organisms suggests the need of some other criterion. When we come to attempt to correlate either smell or taste with chemical composition we are met with serious difficulties.

The sense of taste is shown to include at least four distinct senses—sour, saline, bitter, and sweet. Experiments show that the fish is aware of the position of the stimulus, turns to it, and swallows the meat. The response is absent when the nerves to the taste-buds are cut.

Then sensations produced by various chemical irritants are to be distinguished from those of pain, although both are devoid of differentiated receptor organs and are mediated by free nerve endings. The chemical sense is said to be abolished by a smaller dose of cocaine than is the sense of pain. They have in common, however, a high threshold value, as would be expected from the nature of the structures stimulated. As the object of the sensibility is mainly to avoid injury, too great a delicacy would clearly be a disadvantage. The olfactory sense is regarded as the most primitive, that of taste the most highly developed, with the common chemical sense as intermediate in evolution.

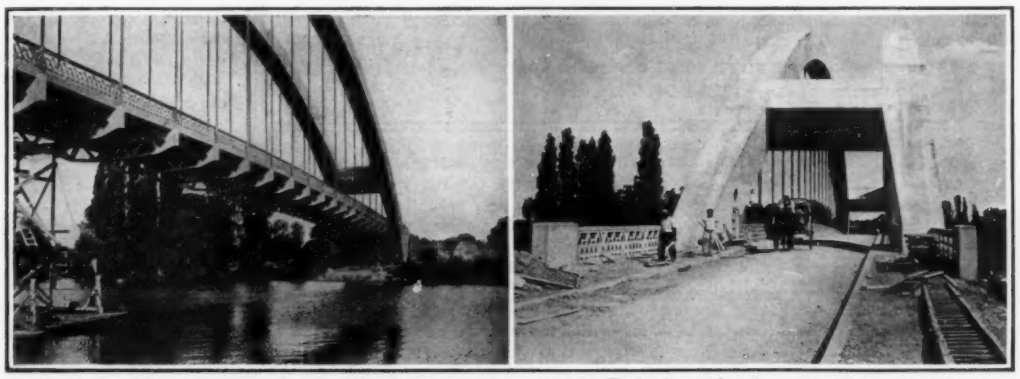
—Abstract from "Nature", for May 12, 1923.

Longest Reinforced Concrete Bridge of Its Type in the World

FRENCH engineers have been strikingly successful in the design of long-span bridges, in which particular attention has been paid to the matter of artistic appearance. In many instances, they have shown positive daring by departing from conventional methods where the exigencies of the site or the above mentioned desire to secure beauty of appearance were controlling factors. Every visitor to Paris must have admired the Alexander Bridge with its slight rise of only 17½ feet as it spans the Seine from bank to bank.

Another beautiful bridge of long span was opened for the service of the public by President Millerand on October 14th of last year, likewise bridging the Seine. This structure is claimed to be the longest reinforced concrete bridge of its kind in existence. The length of the span is given as 390 feet, and the highest point of the arches rises to 97½ feet above the river. The bridge provides a roadway sufficient for two lines of traffic, with two sidewalks for pedestrians flanking the roadway.

The most striking feature of the bridge is the two main bowstring girders of reinforced concrete, the cross-section of which increases gradually from the crown to the abutment. The girders are braced together only at two points, one near each abutment. This portal bracing serves to maintain the arches in their true relative position and prevent any distortion or overturning effect due to lateral wind pressure. The floor system also has been so designed as to assist in carrying the wind loads and transmitting them to the abutments.



Left: Underside of bridge, showing the floor beams. *Right:* End view, showing massive portal bracing

The floor of the bridge is supported by twenty pairs of vertical suspenders, which extend from the arches to twenty transverse floor-beams. One of our illustrations shows very clearly the construction of these floor-beams, each of which consists of a Warren truss extending across the full width of the bridge and sufficiently beyond the balustrade to permit the vertical suspenders to take hold. To protect them from the weather the floor-beams are encased in concrete and upon them are laid the longitudinal stringers and the concrete roadway surface.

The engineer's calculations were verified with great accuracy in the loading tests which were carried out upon the completion of the bridge. The provisions for stresses due to dead, live and wind loads and to changes of temperature were most carefully worked out and, in spite of the severity of the test loads, the concrete has been singularly free from cracks or other disfigurement.

Handsome reinforced concrete arch bridge of 390 feet span, across the Seine at St. Pierre

Unique Radio Museum

A NEW kind of museum has been begun. Realizing that the time will come when new generations will be interested and curious to know what manner of apparatus was used, or rather, "put up with," in the present or early stages of the development of radio, a Cincinnati manufacturer of radio apparatus has placed in a small museum adjacent to the broadcasting station WLW several early types of telephones, such as the old mechanical or vibratory diaphragm, "tincan" telephone used in 1845, and the crystal receiver as first used before the perfection of the vacuum tube. Various forms of apparatus connected with radio which will probably soon be superseded by better go to make up an exhibit which will be of great interest to the radio fan of the future.

The Engine as a Brake

What Happens When We Roll Down-Hill with Gears in Mesh and Ignition Off

By Numerous Readers and the Editors

FIRST among the objections advanced against the use of the switched-off engine as a brake is the claim that the muffler is likely to be blown out. The explosion in the muffler after switching on the ignition occurs because the first hot, exploded charge catches up with the last cold, unexploded charge, igniting the latter. But the remedy is as simple as the cause. As the car nears the point where the power will be required, the clutch should be disengaged, and held so for a second or two until after the ignition switch has been closed. In this brief interval the engine, now free, slows rapidly under the retarding force that enables it to act as a brake; and when the first exploded charge reaches the muffler, the cold charge that preceded it isn't there—it has reached the atmosphere. There will be no back-fire, and no blow-out muffler.

As evidence of the sufficiency of this practice, it works with the flivver. Lizzie has no truly neutral position of her clutch; wherever the pedal stands, if the high speed does not drag the low will. The editorial flivver has been braked in this fashion on hundreds of hills, if not thousands; and the muffler is the one part of the original car that remains. On a car with a positive neutral position of the clutch, then, one may be completely insured in this way against back-fire in the muffler.

SELDOM have we had a more enthusiastic response to an invitation for general discussion than was manifest in the reactions to our editorials of February and March, 1923, on engine braking. Never has the general level of comment been higher. We had planned merely to have a correspondence page of these letters and of extracts from them; but they are too good for treatment other than in a regular article. This has been delayed by the fact that the automobiling member of the staff is the psychic member, who has had all he could do, and a little more, these few months. But, at last, here it is.—THE EDITOR.

More serious is the matter of oil dilution. In the absence of an explosion and of a hot blast in the exhaust, the incoming mixture remains relatively cold and far less effectively carburetted; and in this state, it cuts the oil film from the cylinder walls and from the pistons. At the same time, as the engine cools (rapidly; see below) the ring clearance becomes greater. All this means more gasoline in the crank-case oil.

Most cars have on the dash a device for enriching or thinning the carburetor mixture while the engine is running. When this is not supplied, it usually can and should be added; for present-day conditions make it almost an essential. With it, the driver with an eye for details coasts with a mixture that is almost entirely air, preventing excessive oil dilution and saving gas.

Mr. F. C. Butler, of Cleveland, has the one brand of popular carburetor that does not permit dashboard adjustment. He has installed a valve whereby he can admit air into the intake, above the carburetor, "either in limited quantities through a needle valve for lean running, or in such large amounts as completely to cut off the function of the carburetor." He opens this valve wide when coasting with the engine as a brake. He thus gets a maximum of freedom from oil dilution and of gasoline economy, and incidentally, is relieved of the necessity of touching ignition or clutch.

Mr. Butler remarks that when he opens this valve while coasting, he can feel the car jump forward as though relieved of a load. "This is slight," he says, "but none the less evident." Any driver who will open the throttle suddenly while coasting will be able to duplicate this verification of our statement that the closed throttle gives the maximum braking power. Numerical valuation of the advantage comes from Mr. Otis Presbrey, a Brooklyn engineer. Tests made under his direction with two familiar automobile engines, a four and a six, yield the results summarized in the attached table. Both engines were driven through a dynamometer, the four at 810 revolutions per minute corresponding to a high-gear car-speed of 19.75 miles per hour, the six at 820 revolutions or 16.76 miles.

Few of our readers proved themselves sufficiently poor observers or poor reasoners to disagree with our bald statement of fact. But numbers of them disagreed, more or less fundamentally, with our analysis of the causes. We said "Every iota of energy spent in the compression is returned, during the dead stroke, by the pressure of the expanding air against the moving piston." Though we immediately made it clear that this statement referred to the ideal case that never occurs, and that in any actual engine there was dissipation of the compression energy in various directions, several of our readers are quite certain that one of these channels of loss is wider than our remarks would indicate. From what is said by Mr. Presbrey, Mr. V. E. Jakl of Washington, Neb., and Dr. C. C. Mintner of Newark, N. J., a very complete discussion of the adiabatic action during the compression and expansion strokes could be given.

Theoretically an adiabatic process is completely reversible, and we get exactly as much work from a gas by expanding it as was spent in compressing it. Actually, the fact that the compression process heats the gas renders a 100 per cent return impossible; for there is no way to prevent the radiation and conduction of this heat. The loss corresponds to loss of part of the compression energy; we can expand the gas *ad lib.* and we shall never be able to get this energy back. In the case before us the debt is paid by the moving car; some energy *is* absorbed and some braking done on the compression-expansion half of the cycle.

The exact amount of this loss—or, in this instance, gain, since we are in the unusual position where the more energy we lose the better off we are—depends upon numerous factors. The conduction coefficient of the cylinder walls, the rapidity of water circulation and the radiator efficiency, the engine speed as measuring the time available for distribution of the lost heat, the initial temperature of the cylinder walls as indicating the amount of heat which they can absorb from the compressed gas—all these and other items figure. Though we are sure that those who attribute the major part of the braking to this effect are wrong, the loss in this direction is certainly larger than a hasty first glance would indicate. Evidence of this is seen in the extreme rapidity with which coasting cools the engine.

Several correspondents make this point, but only Mr. W. A. Garratt of Covington, Ky., brings out the utility of the coasting procedure in cooling the engine after a long climb. In our own experience, this is one of the major advantages of "compression" coasting. A cooling system that will keep the engine temperature down below 200 degrees Fahrenheit when the engine is firing, will obviously cut it far below that point in the absence of combustion heat. So intense is this cooling effect that, after a long coast, we always have to enrich the mixture temporarily in order to insure that our engine fire regularly. When we reach the top of a hill with the engine boiling, we find that we can cool it more expeditiously by slipping down the other side with the dead engine in gear than by standing at the summit waiting for Nature to take her course.

There are other channels through which the compression energy may be dissipated. Mr. Jakl points out that there is a thermal effect on the intake-exhaust half of the cycle, if we brake with closed throttle. The intake stroke then rarefies and cools the entering air, and renders it capable of absorbing more heat from the cylinder walls than it otherwise could.

Again, piston rings are never absolutely tight; and as the engine cools they get looser. Compression energy leaks away through them and is never regained. Then, too, the valve-spring resistance is against the engine on opening and with it on closing. Failure of the springs to attain absolute elasticity measures the difference between absorption of power in opening and return of power in closing.

Still another feature of the cycle, which we must confess we had overlooked entirely, is brought out by Mr. S. W. Taylor of Allentown, Pa., Mr. J. E. Padgett of Indianapolis, and Mr. V. V. Gunsolley of Minneapolis. The intake and exhaust valves are differently timed, making the compression range considerably greater than the firing range. Quoting:

"The intake valve closes for the compression stroke anywhere from 20 to 40 degrees past lower dead center, and the piston compresses the air until it reaches top dead center—a range of 160 to 140 degrees. Then the compressed gas reacts on the piston and helps force it down. But this does not last as long as the compression, for the exhaust valve opens anywhere from 65 to 45 degrees before bottom dead center. The expansion stroke has then a travel of only 115 to 135 degrees." If this were merely a matter of the time available for expansion, there would be faster emission of heat and a balance would be struck. But when the valve opens, compression is in part replaced by discharge. The entire body of air never returns, *in the cylinder*, to its original volume or temperature; it takes out the exhaust with it heat which it would have to give up to the cylinder walls if it were to maintain an adiabatic balance.

Mr. W. R. Ward of Lyells, Va., makes another interesting point. Intake and exhaust passages are of different contour, the resistance offered to air-flow by the intake being much the greater. The closed throttle brings the intake resistance to its maximum, the open throttle does the same for the exhaust. That is to say, when we close the throttle, we maximize the thing that has the biggest maximum. Mr. Presbrey's figures take added interest here, indicating that a very little opening of the throttle breaks up the intense vacuum in the intake and seriously affects the braking power.

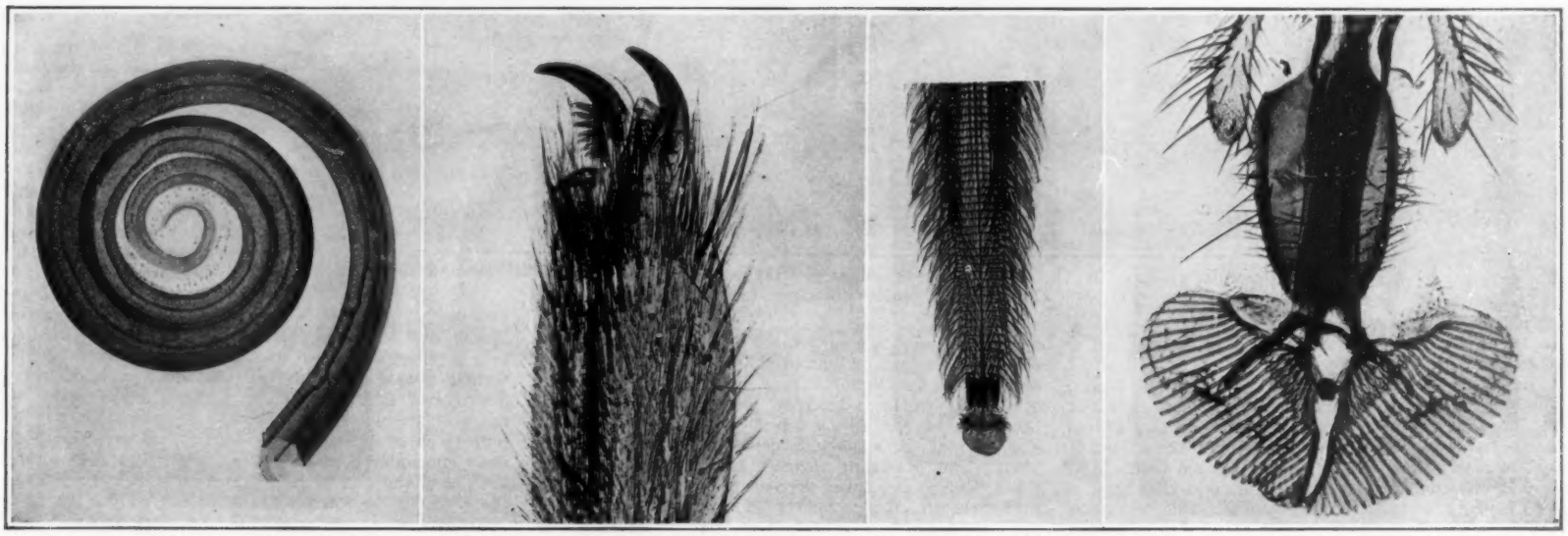
Of all our original assumptions, that which caused our readers the most uneasiness was our ignoring of the running friction of rear axle, transmission, bearings, etc. Numerous readers insist that this friction accounts for most of the braking power. This we cannot admit. Mr. J. E. Meikle of Castle Rock, Wash., Mr. W. A. Kelley of Brooklyn, Mr. J. E. La Mont of Manhattan, Kan., Mr. Gunsolley and Mr. Padgett all discuss this phase of the situation interestingly. Mr. Padgett cites the Bureau of Standards experiments, described on page 82 of our February issue. Here we learn that to pull a certain car in neutral required a tractive effort of 70 pounds, while to attain the same speed in high and low gears required, respectively, 110 and 220 pounds. But the Bureau here made no effort to separate the running friction from the absorption of power by the engine cycle. We do not know just how this separation might be made; but the anecdote we are about to set down will indicate its general result.

How the Engine Develops Braking Power

Throttle position	*Retarding force of engine on car:* *Four*	*Six*
Closed	84.5 foot-pounds	130.9 foot-pounds
One-eighth open	72.1 "	110.0 "
One-quarter open	68.5 "	99.0 "
One-half open	61.6 "	96.4 "
Three-quarters open	61.6 "	93.0 "
Wide open	61.1 "	93.0 "

Our car had been overhauled by a mechanic who suffered an obsession about getting everything extremely tight. It is his custom to make bearings and pistons so tight that, before the car can be run under its own power or before the engine can even be started, the car must be towed for some miles with the engine in gear. With our car, the first attempt to do this failed signally; the "towed" car was merely dragged along the ground without rotation of the wheels. The spark plugs were therefore removed, and the intake and exhaust manifolds taken off. With compression and pumping stresses thus eliminated, the towed car ceased sliding and started to roll without further difficulty. It would appear from this that, even with bearings absurdly tight, the absorption of power in the operation of the engine cycle is greater than the loss through running friction, and that it is really the engine, and not the bearings that acts as a brake.

Uncommon Views of Common Insects

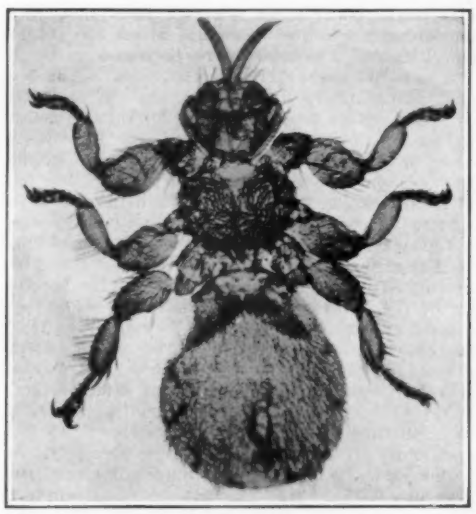


The tongue of the butterfly, magnified 23 diameters

The foot of the spider, magnified 50 diameters

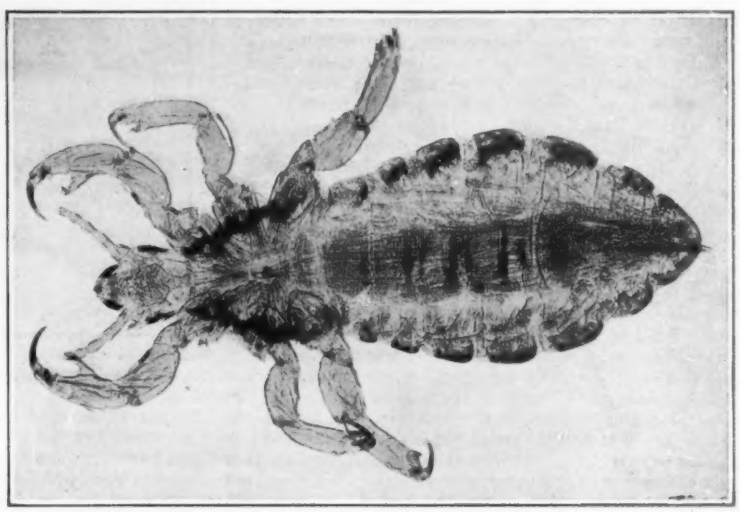
Tongue of bumble bee, magnified 100 diameters

The tongue of the common house fly, magnified 40 diameters

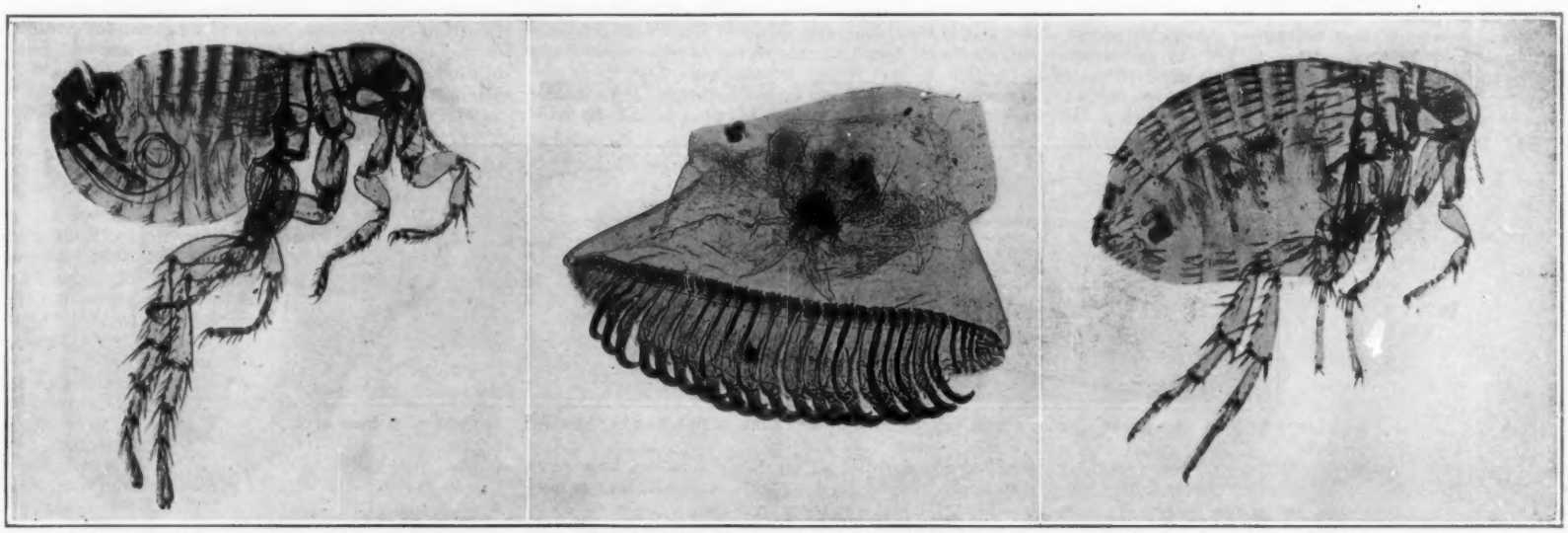


Interesting portrait of the sheep tick, magnified 8 diameters

THESE excellent photomicrographs were made by Miss Mary Allard Booth of Springfield, Mass., whose work in this field has won for her world-wide recognition. Miss Booth has prepared a collection of photomicrographs of parasites for the Bureau of Entomology of the U. S. Department of Agriculture. The essential apparatus for photomicrography consists of a microscope with a firm base placed in a horizontal position, lenses, and a camera. The lower power lenses are always known as dry lenses. The higher power lenses are chiefly what are known as immersion lenses; that is to say, between the specimen and front lens of the objective, an immersion fluid, sometimes water but usually cedar-wood oil, is used. The object of this immersion fluid is to enable a wider beam of light to be utilized by the objective.



Our old friend, the "Cootie," magnified 25 diameters. His Latin name is Pediculus Vestimenti



Side view of human flea, male, magnified 20 diameters

The foot of the caterpillar, magnified 33 diameters

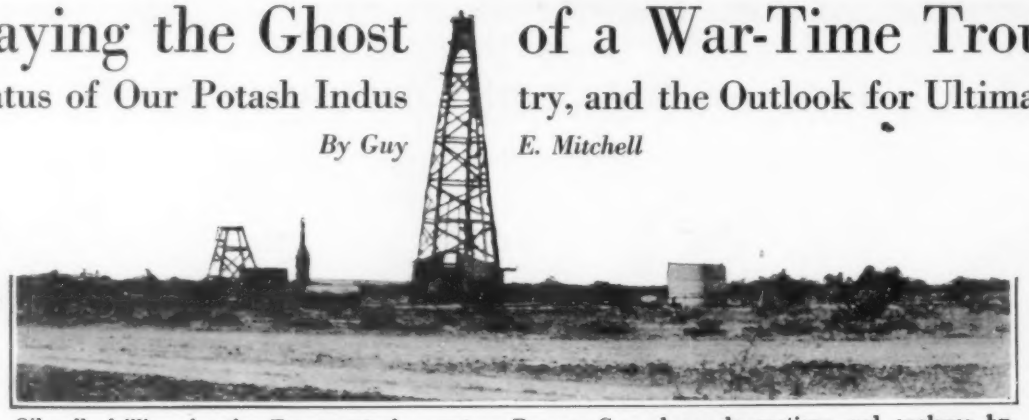
Bubonic plague flea of rat, magnified 33 diameters

Laying the Ghost of a War-Time Trouble

The Present Status of Our Potash Industry, and the Outlook for Ultimate Independence

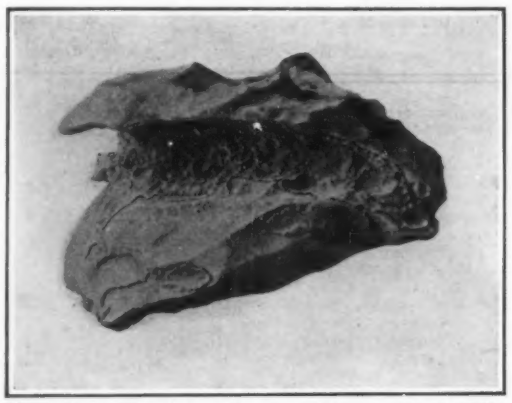
By Guy E. Mitchell

THE United States Geological Survey has announced the discovery of potash in the West which it is believed may develop into a find that is comparable to, may even be larger, than the huge Stassfurt deposits of Germany. If so, its value will be almost beyond calculation. It is hardly necessary to mention the importance and value of potash. The problem of getting cheap potash is one that will affect the pocket-book of every person in the United States. Potash, like phosphorus and nitrogen, is one of our vital needs. No plant can grow without it. Unless there is potash in the soil we cannot produce a loaf of bread or a pound of meat, a vegetable, or a fruit. And the available supply at the present time is very hard to get—Germany controls it. We have again become practically dependent on Germany for our supply of potash salts in the United States. Last year our production of American potash was only 11,714 tons (K_2O). When the German exportations were cut off by the war the United States was driven to extremes to produce sufficient potash for our minimum requirements, but in spite of very strenuous efforts, comparatively little was accomplished. Some potash was produced from saline lakes in the Middle West and in Death Valley, California, at a cost to manufacture several times that of the German potash, and during the period of the exclusion of the German potash some potash was also extracted from western alunite rock deposits. Attempts were also made to extract commercial potash from kelp, the huge sea-weed of the Pacific Coast, and this is even now being done to some extent, but is only possible on account of the valuable by-products. It seems strange that while the huge deposits of potash salts of Germany and Alsace-Lorraine are the only known large deposits in the world, potash is nevertheless one of the most abundant minerals. It is found in whole mountain ranges of rock here in the United States as well as in other countries—rocks which are known as "potash rich"—containing relatively large percentages of this mineral. The trouble is that Nature has locked the potash up so tightly in these rocks that no method has yet been developed which will release it except at a prohibitive cost. Scores of processes have been evolved on account of the tremendous demand for potash, and many of them patented, but no process has yet been developed on a commercial scale which will anywhere near supply the demand.



Oil-well drilling in the Texas potash country—Reagan Co., where observations and analyses by Government geologists show underlying potash beds

Potash is also obtainable in limited quantities as a by-product in the manufacture of cement and other products, but all of these sources of American potash are either very limited or the cost of extraction too high to enable them to compete with the great German deposits. If we are to compete with these foreign deposits we must either develop a chemical process for cheaply extracting the potash from the unlimited supply of potash rich rocks or we must discover and develop some great natural supply of potash salts like the German deposits. The chemical method will doubtless be realized some day but the discovery of natural potash deposits seems to be the most promising at this time. The United States Geological Survey has been engaged for a number of years in exploratory work mostly in the West, since geologists have believed that there must be somewhere great natural deposits of potash salts; but the ridiculously small amount of the appropriations available has permitted of government test drilling only here and there and of more recent years, observations of private drilling operations carried on primarily for oil. These latter have, however, convinced the geologists that there exists in Texas a great deposit of potash salts. Oil being the objective of all these drilling operations and not potash salts, the records kept by the oil men have been of limited value. The evidence gathered by the Geological Survey, however, strongly indicates that we have in West Texas, and probably in Southeastern New Mexico, beds of potash salts within 1200 feet of the surface, a depth workable by mining shafts, and extending through large areas. Some of the drillings show large percentages of potash and it is pretty certain, the geologists state, that in this region the nation possessed enormous reserves of potash. This



Mineral sample from the new Texas potash field, with potash content of 12.5 per cent

region is part of the great Red Beds region of the Southwestern United States where we have a series of sandstone, shales, limestones, etc., which through an interval of 1000 feet, more or less, carry beds of salt estimated by the Geological Survey to contain 30,000 billion tons of rock salt. It is the greatest known salt field in the world. The rock strata are similar in composition to those carrying the vast potash deposits of Germany and they were formed at the same period of the earth's history, and under largely similar conditions, and it has been generally assumed that potash if present, would be found in this region of the greatest salt deposition in the West. Potash salts have been discovered in these salt areas, but as stated, the exploratory drillings were for oil and not potash, and the drillings have been so mixed up that the potash beds have not been clearly defined. But it is a fact that potash has been found here, there and yonder, over an enormous area—about 275 miles long by 125 miles wide. To definitely determine where the potash deposits are located will require the sinking of core driven wells, an expensive operation, but one which when successful will be rewarded with one of the most important necessities in both times of peace and war.

Arm of the great Cardona salt lake, Crane Co., Texas, which lies in the newly discovered potash area

Kainite is one of the natural potash salts of the German Stassfurt deposits which is largely imported into the United States in a somewhat impure state and sold direct to the farmers. It contains in such commercial form about 12 per cent potash (K_2O) and sells for about $15 or $16 a ton. The most promising and significant of the Texas potash investigations comes from the Means well in Loving County which has been drilled to a depth of over 5000 feet, and analyses made by the United States Geological Survey for potash of every five feet of material drilled. These analyses show all the way from a trace of potash to more than 11 per cent (K_2O). A number of relatively rich potash beds were encountered by the drill. From the 1240 to the 1245 level the potash content was 6.41 per cent.; from the 1245-1250 level it was 3.97 per cent; from the 1250-1255 level, 4 per cent and 1255-1260 level, 3.22 per cent. Here is an average of 4½ per cent of pure potash in 20 feet. In the 1735-40 level the analysis shows 4.82 per cent; the 1740-1745 level, 9 per cent, and the 1745-1750 level, 7.92 per cent, while the 990-995 level analyzed 11.21 per cent. The potash is in the form of a hard salt known as polyhalite which has about the potash value of kainite. Absolutely pure polyhalite contains 15.6 per cent potash (K_2O), so that this 5-foot bed contains comparatively little impurities. It is water soluble and requires no treatment other than crushing or grinding to be used as a direct fertilizer. It remains, of course, to be determined how far these beds extend and this can only be realized by further drilling but geologists are of the opinion that the drill will show the beds to be persistent and that it will be strange indeed if thicker beds are not discovered. Considering this 11.21 per cent analysis, which is the most favorable yet determined, let us see what we have. The specific gravity of polyhalite is 2.67, so that a five-foot bed would yield 17,690 tons of potash salts containing 11.21 per cent (K_2O) to each acre. What the cost of mining would be is not here considered but at current market prices to the farmer we have a potential value per acre of perhaps $250,000. In short, commercial potash salts have been discovered in the United States.

Potash as we all know is a prime farm necessity. As our farming soils become poor, we must stimulate them with fertilizer—the three important constituents of which are potash, phosphate and nitrogen. The more widespread and effective fertilization of the soils of the United States is not merely an agricultural requirement; it is a national necessity upon which depend the commercial welfare and prosperity of the country in the near future. Our national financial independence cannot be sustained indefinitely by the use and export of the products of even the greatest mines in the world. We must continue, as in the past, a great agricultural nation, and export products which can be replaced. The replenishment of worn-out soils is one of the very biggest things before this country today and well recognized as such. Americans are very fond of saying and hearing that their enormous production of corn, hay, fruits, vegetables and live stock is the backbone of the United States; but the wearing out of American soils constitutes a menace to this nation, the disastrous and far reaching significance of which is little realized by a public habitually optimistic and complacent. It is simply voicing the opinions of some of the most level-headed men of the country to say that this question of farm fertility is the most important economic problem of the United States and that beside it our war debts are trifling and ephemeral. This is a strong statement—that compared with the importance of this problem of the continued fertility of our farming lands, our

(Continued on page 216)

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

Reservoir and siphon of the home soda-water fountain

A Soda-Water Plant in the Home

SOME years ago an inventor introduced a siphon which charged itself from liquid carbonic acid gas contained in capsules built to withstand the enormous pressure. Such siphons are now being sold once more. The device we show, however, is different in that the liquified gas is contained in a metal tank or bottle so that the siphon can be easily charged. The bottle has a real "valve-in-head" and there is a gage and a release valve on the tubing. To charge it is only necessary to fill the siphon, which will hold 44 fluid ounces, with water, preferably distilled. The holes in the safety casing show the height of the water to be carbonated. The cap shown in the foreground is unscrewed from the charging tube in the siphon-head, the flexible tube is attached with the aid of a screw-nipple and the gas is allowed to flow from the bottle at a pressure of 160 pounds until the siphon is charged. An automatic blow-off valve releases the gas when carbonation is completed.

A Cake-Shell Pan

THE cake baking pan, which we illustrate, is made of one solid piece of aluminum, as it has been found that this metal brings a more even heat to the dough or batter than any other. This pan is adapted to form a cake-shell for fresh or canned fruits, gelatine, custards, whipped cream, marshmallow whip, meringue, etc. Any recipe for cake may be used and the result is an attractive shell, which will do away with extra saucers for the fruit. The appearance of the dish is most attractive. There are two sizes, one as shown, and individual cakes of a smaller size for single service such as fruit tarts.

For baking cake shells to receive fruit fillings

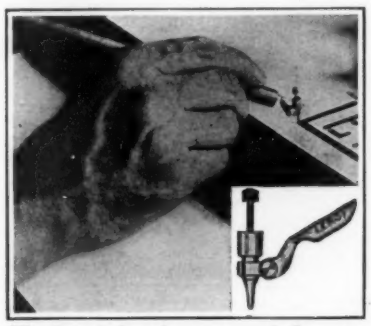
Wrenches of Chrome Vanadium Steel

THROUGH the use of chrome vanadium steel, a forge and tool works of Allentown, Pa., has been successful in developing wrenches that are thinner, longer, and stronger than the usual carbon steel wrenches of the same opening. The use of this alloy steel allows refinement of design, both in shape and thickness of head. The thin pear-shaped head, made possible by the use of alloy steel, makes this line of wrenches lighter, better balanced, and more serviceable in confined places, combined with unbreakable strength. These chrome vanadium steel wrenches are available in sets of assorted sizes, to fit a wide range of U. S. Standard nuts, S. A. E. nuts, and hexagonal cap screws.

The same works have introduced chrome vanadium tappet wrenches—long, thin wrenches which allow the mechanic to work clear of the motor when it is hot—the only time for adjusting—while the angle of the heads allows him to reach inaccessible positions. As most cars require three wrenches to make complete tappet adjustment, these wrenches are designed so that two can be worked with one hand while the third is used in the other hand. This is accomplished by having two openings, both the same size but at different angles, on each wrench. One opening is straight, while the other is set at 22½ degrees.

The Tubular Ruling Pen

MOST steel lettering-pens have to be selected for stiffness of nib, to suit the particular user. Too much ink on the pen causes blots and poor intersections. A tendency to bear too heavily spreads it and makes vertical strokes wider than horizontal ones. The great care necessary in these connections, it is claimed, is obviated with the use of a new tubular pen, which is supplied in connection with a goose-neck member which enables it to be used with any ordinary pen-holder. Being tubular, lines of uniform strength are insured, no matter what the direction of the stroke or the pressure behind it. Ink is placed, by means of a dropper, in the little cup on the shank of the pen; the member projecting above this reservoir is a cleaner; it is carried in this position for use as a primer, a function which it performs through its very slight projection beyond the nose of the pen, so that it scrapes on the paper and vibrates in such manner as to agitate the ink. Any mark it makes, obviously, is in the path of the pen itself and is swallowed up in the line which the latter draws.

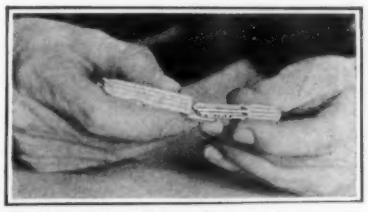


The latest drawing pen, and the way to use it

One of the major advantages claimed for the apparatus is that it is used with a stroke practically the same as that of ordinary penmanship.

The Vest-Pocket Seal

SOMETHING decidedly clever in seal-presses is offered—nothing less than a pocket seal. As our picture shows, it looks very much like an ordinary watch case, the places on the inside ordinarily occupied by the dial and the sweetheart's photograph being filled by the two faces of the press. The illusion is heightened by the handle, which is in the design of a watch stem; so that when closed and put away, one has in one's pocket, to all external intents, a watch. In use, the paper to be stamped is placed between the two faces, which are closed down upon it, and one then delivers as much of a knock-out punch with the closed fist as may be necessary to transfer the impression.



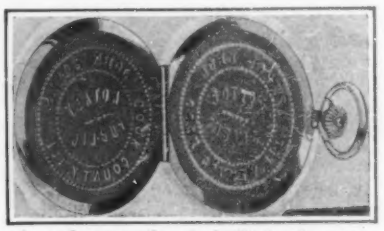
Knife and latch-key in one, for small pockets

A "Tuxedo" Knife

MEN'S dress clothes are thin and a bunch of keys is apt to make an ugly looking bulge. After the dinner or party is over one must go home and the latch key must therefore be carried. An inventor conceived the idea of introducing a key into the end of a knife which is often carried at the end of a watch or key chain. Naturally every pin, or "Yale" lock, as they are usually called, is different, so a blank is furnished and not a key, but with the little key-duplicating machines it is possible to cut in the proper notches in a minute. If it is not convenient to do this, the knife and a key may be sent to the manufacturer, who will make a key out of the blank and return to owner. It will be noticed that the pattern on the knife frame is carried on the handle of the key which forms a part of the frame when the key is thrust home.

A New Electric Siren

THE little electric siren is only a few inches high but is little in size only, for the screech of the little red head is terrible. This is supposed to be an "indoor" size, but it would answer for a small town perfectly well. A steam or air siren is all right where pressure is obtainable day or night, but this is often difficult, while electricity is always available. The small size which we illustrate is only 10 inches high and is actuated by a one-twelfth horsepower motor. The relatively large rotor is surrounded with a wire screen to keep out birds and sleet and is equipped with a sheet metal roof which also serves as a sounding horn and distributes the warning in all directions. As a burglar alarm for banks, it is particularly useful as it may be sounded from any point. This siren has several elder brothers which are all right for outdoor use and render fire signalling easy.



A seal press that is built in the pattern of a watch

Machine for Testing Gears

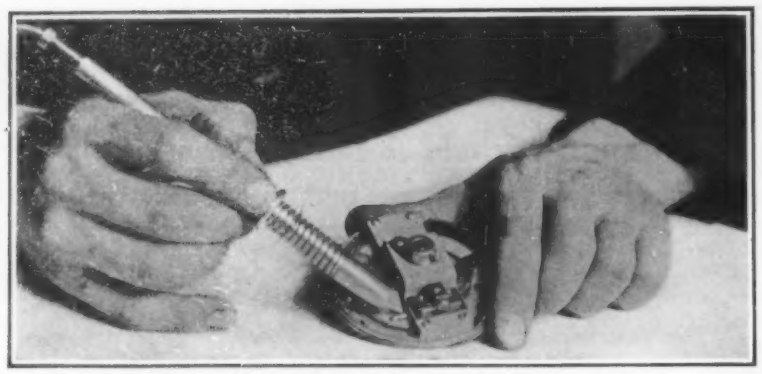
A GEAR tester has recently been developed and placed on the market. The instrument is primarily intended for ground gears but can be used equally well on cut gears for developing, checking and charting involute curves and testing tooth spacing.

The machine consists of a base with a longitudinal slide upon which a transverse slide is mounted. Both slides are moved by screws with hand-wheels and micrometer heads. A slot is machined at one end of the base, in which a stud for mounting the gear to be tested is clamped. On the transverse slide are mounted the contact finger or needle and an indicator by which the readings are taken.

For testing the involute curve of a tooth on a spur gear, an adapter with a base circle disk and steel tapes 0.005 inch thick are used. The indicator may be set to read direct or to multiply the readings by four. It is evident that as the transverse slide is moved, the contact finger will trace a true involute relative to the gear, since the tapes cause the slide to move a distance equal to the peripheral motion of the base circle disk. To take readings the transverse slide is set at zero and the contact finger is set at right angles to the slide by means of a gage. The gear is then set on the stud with the indicator reading zero, and if the indicator remains at zero as the transverse slide is moved, the tooth curve is shown to be a true involute. Any deviation from the true involute is shown on the indicator and may be charted. To assist in gathering data for charting the curve, a plunger automatically retards the handwheel every 0.010 inch. The charted curve for a true involute will be a straight line.

Tooth spacing is checked by using a

Electric siren that works from any light socket



Electrically heated soldering iron for small work

fixed contact finger clamped to the slide, in connection with the indicating device. Tooth to tooth spacing or 90-degree spacing may be checked. When it is desired to maintain a master curve or duplicate an established form, the longitudinal slide is used, first plotting the master and then checking the other curves with the chart. By making special adapters, spiral, bevel and other gears may be tested for spacing and contour. The normal capacity of the instrument is from one-half to eight inches, spur, helical and bevel gears, and the maximum is up to 12-inch spur gears.

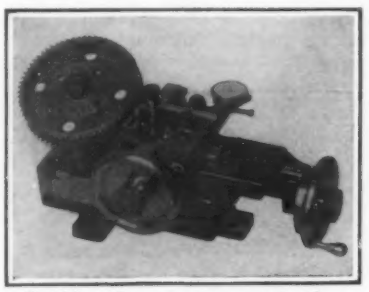
A Portable Hot-Water System

EVERY mail, these days, brings us pictures of devices being marketed in Germany for making one shovelful of coal do the work of two. Among the latest group of these, interest attaches to the portable hot-water heater which we illustrate. This, as far as we can make out in the absence of adequate details from our correspondent, is connected on to the house water system, presumably by running a hose connection to a faucet. When the fire burns, the water circulates, in the familiar thermo-siphon fashion, inside the cylinder until the valve to the bath-tub spout or that to the shower connection is opened. It is just like the familiar kitchen boiler of the American home, save that it can be taken to any room—and, in the absence of hot-water pipes in the plumbing, must be taken to any room in which it is to be used.

Hot water without hot-water pipes

Make Your Own Pie Charts

IF you want to show where a dollar goes or where your receipts come from, a divided circle or "pie chart" is generally used. Formerly, we had to draw a circle and then divide it roughly into degrees and calculate the percentages, draw radii and then color the segments. Then along came the graphic stationer (who can sell two or three hundred different kinds of rulings, bar charts, circles, maps, etc.) with a handsome circle divided into percentages and only waiting for the radii and the color. Now we have one more improvement, by which for the small sum of thirty-five cents, you can make a colored pie chart in an instant. The charts are 4¼ inches in diameter and consist of seven disks divided into one hundred parts, with graduations on the outer edge. There is one cut from the center to the periphery which allows a disk of another color to be inserted; this operation can be repeated until the seven disks have been utilized. It is seldom that there is necessity for dividing the circle into more than seven segments and the percentage of each can be determined in an instant. It is a real time saver and will prove useful in any office.



Rapid and accurate gear testing

The Motor-Bike Fire Engine

DECIDEDLY surprising must be the verdict of one who sees for the first time what a complete fire-fighting equipment it has been possible to mount on a motorcycle, as illustrated herewith. There is carried a side car in which the chemical equipment and tools are packed, and on the forward part of the body a rugged iron cage for the stowing of 150 feet of hose. Suspended on the sides of this cage are four carbon tetrachloride fire-guns for combating gasoline fires, and others of the sort. On the rear of the side car are carried two larger extinguishers of standard chemical types. Inside the car there is a reducer valve for connection between the regular 2½-inch hydrant and the ¾-inch hose carried. There are in addition numerous fire-fighting tools of the usual sorts, all this comprising part of the equipment supplied by the maker.

The Soldering Iron for Small Jobs

SMALL soldering, like any other small work, demands the use of a quality instrument, and not a large cumbersome tool adapted for entirely different work. We illustrate an iron designed to meet this need. Constructed entirely of metal, it is fitted with a German silver tip insuring minimum oxidation, consequently infrequent renewal, leaving a clean, smooth surface at all times. Heating is by electricity. The heating element is composed of the highest quality nickel chromium. The cord is protected, where it enters the handle, with a light metallic spring coil, which prevents fraying or other wear at this vital point. In operation, the hand is comfortably near the soldering point, enabling one to work speedily, economically and visibly—which is not the case when using a big tool as a makeshift. The iron, according to the maker, operates on any voltage and either alternating or direct current, and may be used with the standard screw socket or the base plug.

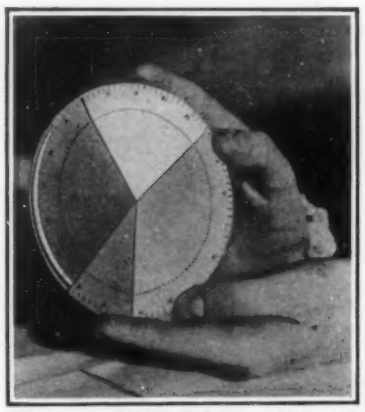
Transparent Metals

IT has long been known that thin sheets of gold and silver, mounted on glass, may be made transparent by heat; but it is only within recent years that serious study has been given to the conditions under which such transparency may be obtained.

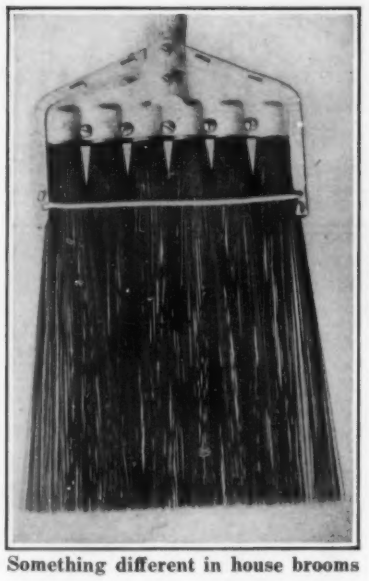
It is said that a sheet of gold one three-hundred-thousandth of an inch thick becomes transparent when heated to 550 degrees centigrade. The transparency is ascribed to the gold aggregating and allowing white light to pass through the interstices.

With silver one hundred and twenty-thousandths of an inch thick no transparency is produced so long as the atmosphere is a "reducing" one, such as hydrogen or coal-gas. But in the air the transparency begins at 240 degrees and is remarkably complete at 390 degrees.

Copper one seventy-five-thousandth of an inch thick does not become transparent in a reducing atmosphere, but in air it is transparent between about 200 degrees and 400 degrees.



Pie-plate statistical charts are turned out by this device while you wait



Something different in house brooms

Steel Wire Brooms

A STEEL wire broom is an efficient fire fighter and may be used for sweeping or spanking. It is not at all affected even by severe heat. The fillers, which are removable, will not spread fire, but will extinguish it. For brush and rubbish, it is also extremely useful and is employed in many fire departments for this purpose. If any of the fillers become worn or injured, they are easily replaced. The use of these brooms is, of course, not confined to fire work and they give excellent satisfaction in the garden or the plant.

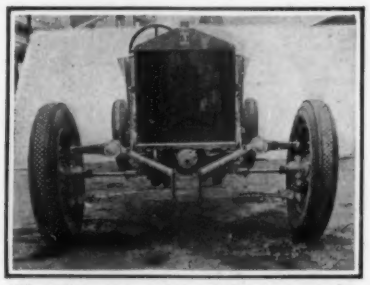
Coloring Oranges With Oil Fumes

AN orange may be inwardly ripe when outwardly green and if allowed to yellow on the trees the marketing may be delayed four to six weeks and consequently a less favorable price may be obtained.

This green condition gives the Satsuma orange grower more concern than others. Satsumas are raised in upper Florida, lower Alabama and lower Mississippi. Normally they are gathered about October 15th, but they can be harvested earlier when artificial processes of coloring are used to get away from the persistent greenness of skin.

The United States Department of Agriculture has worked out a process for coloring oranges without harming the fruit. The process consists of enclosing the oranges in tight rooms and subjecting them to fumes of kerosene stoves or to gasoline engine exhaust. The fumes given off destroy the green chlorophyll so that the yellow of the orange shows up. It requires about four days to bring out the yellow of the oranges by this process. This is better than waiting four to six weeks for the fruit to ripen on the trees, running the risk of frost or storm damage and facing the probability of a lower market when the oranges are ultimately harvested.

Adapting the motorcycle to fire department service



Chassis suspension without an axle

Unique Chassis Suspension

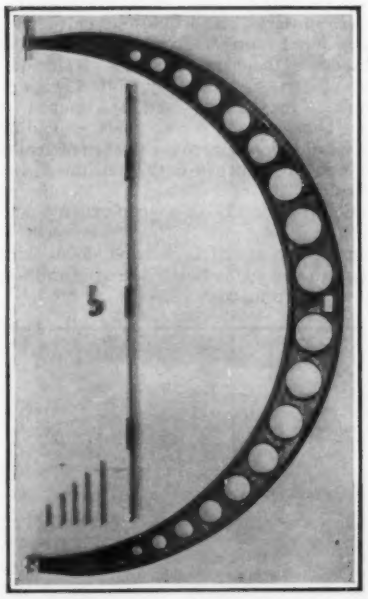
THE axle is entirely lacking in the new models of a well-known French motor car, and in its place is substituted a long transverse spring forming the lower member of a sort of truss, and a peculiar tubular piece for the upper member. This unique construction is employed both in the front and on the rear of the car, and it is stated that it has proved itself a remarkable success in service over rough roads.

The outer ends of the springs are attached by means of clips to the lower bearings of the steering pins. To the center of the spring is attached the upper central member. At the forward end of the car this is a tubular, obtuse-V construction whose outer ends are shaped like mallets lying on their sides. The heads of these "mallets" are concave, and contain shock absorbers which may readily be adjusted. The tie rods are connected by a universally jointed member to a transverse sliding member connected directly to the steering gear.

At the rear of the car the transverse leaf spring is bolted to the underside of the differential casing. The upper side of the differential casing is bolted to a tubular member which connects the sills of the chassis and extends past their rear ends far enough to take the same type of shock absorber and links used on the front of the car.

An All-Embracing Micrometer

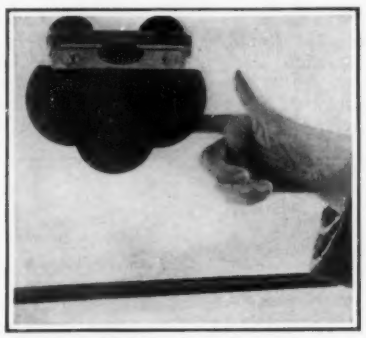
FOUR-INCH micrometers are quite commonplace, but four-foot ones are not. The one illustrated on this page is one of the latter class and had to be built up as a special order. This micrometer weighs 32 pounds, and a special pattern was required for casting the frame. The weight of this delicate instrument is so great that if it were used under ordinary circumstances the distortion element introduced would become a serious error. Therefore it is suspended from a special holding device which will also obviate errors caused by expansion due to the heat of the user's hands. The measuring spindle, barrel and thimble are standard parts from small-sized micrometers, but the instrument itself, which was made by a Providence, R. I., manufacturer, is quite unique in its span.



Specially constructed micrometer with span of four feet

A Vacuum-Held Glare Shield

MOST simple and practical is a glare shield held in place securely by the use of vacuum cups. By an arrangement of small hinges the green celluloid shield can be turned upward instantly. When needed to shield the eyes of the driver it is just as quickly turned down. The vacuum cups hold this shield so securely on the windshield that it can be removed only by inserting a knife blade between the cup and glass to let in a little air.



Cutting off the glare from the approaching car with a shield held in place by vacuum cups

More Room in the Suit Case

A DESIGNER of suit cases has provided a case for toilet accessories that fits into a compartment all its own at the back of the case. When removed from its place in a traveling case, it can be carried separately as it folds neatly into a smaller leather case as pictured in the illustration. The idea of space saving in traveling cases has also been incorporated in traveling bags for men or women.

New Motor-Wheel Doubles Usual Air Space

THE comfort of traveling in a motor car depends mainly upon the air capacity of the inner tube on the wheels. The more air the tube contains, the better it would be able to damp out all oscillations and shocks.

A British inventor has perfected a new motor-wheel, which has twice the usual air space; even light cars fitted with such wheels, it is stated, will travel as comfortably and hold the road as well as well-sprung cars weighing two tons.

The new inner tube has a cross-section like the Figure 8. The upper half of the tube lies inside the tire, as usual, while the lower one is accommodated within the disk wheel. Nine bolts hold the disk wheel together, and where they pass through the tube, pieces of rubber have been vulcanized in, to take the bolt holes. In this way, an absolutely air-tight joint is assured.

To fit the tube to the tire, or to dismantle the tire and tube, tire levers, etc., are no longer needed. By removing the nine nuts, the outer disk comes off, and tube and tire can be taken out quite easily. The air valve projects through a hole in the disk wheel and is easily accessible. As the inner tube is no longer confined within the tire, but is partly in contact with the steel disk of the wheel, all heat generated in the tube, while the car is running, is carried away by the cool air acting on the rotating disk wheel. A longer life of both tire and tube is in this way ensured. Owing to the great air capacity of the tube, much thicker rubber walls can be used, making the tube more nearly puncture-proof than it has been, and preventing sudden bursts.

Testing Gasoline with Molasses

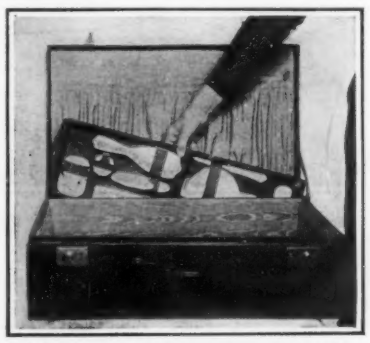
IT has been discovered that molasses is extremely useful for detecting the presence of water in tanks of gasoline. Water is, of course, heavier than gasoline, and it will always sink to the bottom of the tank. In making the test a wooden stick is coated with molasses and this is pushed down into the suspected gasoline. The gasoline does not affect the layer of molasses in any way but, when water is encountered, the coating comes away from the stick. Thus when the stick is withdrawn it is not only possible to see whether water is present but the actual amount is plainly shown by the height of the bare section at the bottom of the stick.

A Packing Case with Possibilities

A BOOM in the artificial kindling business is indicated by the appearance of a new packing box which is said to be indestructible.

In one week six hundred thousand American railway cars are loaded with what is called package freight, most of it inclosed in wood or wood substitute containers which after one train trip go into the furnace like Shadrach, Mesach and Abednego, but not like them to emerge unscathed. Between one-sixth and one-seventh of the total lumber production of the United States, it is estimated, meets this fiery fate after a career in the form of packing cases as brief as that of the silkworm, without leaving behind it anything more valuable than ashes.

Conservationists have been working for years to reduce the mortality of our



Making the toilet accessories take up less room in the suit case

forests; in the new box, it appears, they have found a powerful ally. The box, it is true, is made of wood, but not of wood destined to a few weeks of work and then extinction; the wood that goes into this box has a long and honorable existence before it, comparable to that of which a house is built, and not limited to service in a single site. It can and probably will travel from coast to coast, from gulf to gulf, to Punta Arenas, Kamchatka, Capetown, Calcutta; then, full of years, it can regard the furnace as a crematory and its ashes worthy of preservation in an urn.

The Siamese twins, High Cost of Living and High Cost of Distribution, inseparably joined, view the new box with alarm. Elimination of waste of lumber, saving of stowage space, prevention of pilferage, reduction of claims against carriers for loss and damage, are included in the box's program. It has no nails for thieves to extract, no fragile panels to fracture, and when it is returning from the commercial front or enjoying well earned rest it folds into almost insignificant dimensions, lowering its traveling and storage expenses to a minimum.

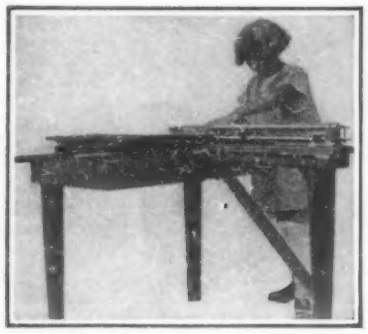
Putting more air under the car than has been possible heretofore

Like all strong things the box is simple. Made of unbreakable boards, with rivetted hinges, it can be contracted to one-eighth its service size instantaneously. One type, now in use, four and a half feet high, folds to a height of six and a half inches and eight folding boxes can be stowed into space occupied by one non-folding box. The size of box, however, is not limited to four feet high. Pianos already are shipped in them, and automobiles and cumbrous machinery can be.

The first cost of the box is larger, of course, than that of a packing case intended to be used only once or twice; but its cost divided by the number of possible trips becomes not much greater than a German mark or a Russian ruble. Some four and a half foot boxes have been used five years on one American railway, and seem to be good for another five.

Profitable as this box has proved in domestic commerce, its potentialities in international trade are even greater. Packing has been one of the worst of export problems. Loss in overseas shipments by breakage and theft has been in many instances the final handicap against American shippers in the keen competition which makes every cent count. Much money has been spent in perfecting pilferage proof cases for foreign trade, with some success; these costly boxes represent an investment which must be recovered in one use. The new cases are not only pilfer-proof, but they do not have to be pulled apart to get the contents out when the shipment reaches its destination. They have merely to be unlocked and unpacked, folded and sent back to their point of

The indestructible packing case



Recently developed machine for cutting glass

origin, to be utilized again and again. They are proof also against the proverbial hostility of stevedores. They can be thrown off a ship on to a concrete dock without breaking, though that practice, in spite of its popularity abroad, is not advised.

Americanizing the Ancient Chinese Game of Mah Jong

IT has remained for American inventive talent to simplify the fascinating Chinese game of Mah Jong, which has swept the country by storm. Instead of utilizing the cumbersome and expensive Chinese tiles of bone and bamboo, the Americanized version makes use of wafer-like tiles, simple striped sticks for the chips, and neat racks to hold the tiles and to carry a simple table for figuring out the scores.

The accompanying illustrations give a graphic description of the wafer-like tiles invented by Mr. Otis F. Wood of New York City. The tiles in this case consist of black and white sheets of celluloid, cemented together, the white side carrying the Chinese symbols of the game. Because of their lightness and compactness, the wafer-like tiles may be readily handled and the game is materially speeded up. Indeed, Mah Jong is now played for the sake of the game rather than for the pretty tiles.

The racks of this Americanized Mah Jong are designed to hold the tiles at the proper angle. Furthermore, the front side is sloped so that the tile is guided to the slot by the hand of the player without his having to take his eyes off the game. The "chips" are little strips of celluloid with simple bands of black and red. All in all, this new game makes for greater concentration and better playing, so it is claimed by its inventor.

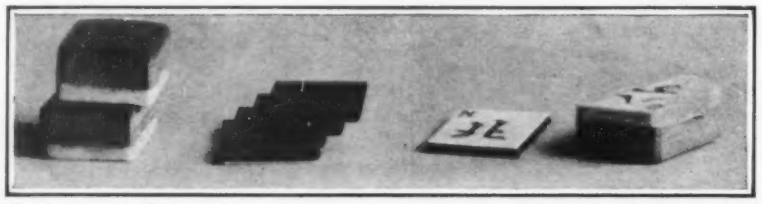
The wafer-like tiles permit Mah Jong to be played anywhere—on the train, on board ship, in the home—everywhere. When packed in an attractive box, the entire game can be placed in a coat pocket. Intentionally, one of our illustrations shows the game placed at an angle, to indicate that the swaying motion of the train or the boat has no effect on the Americanized game of Mah Jong, with its wafer-like tiles.

Salt and pepper from a single shaker

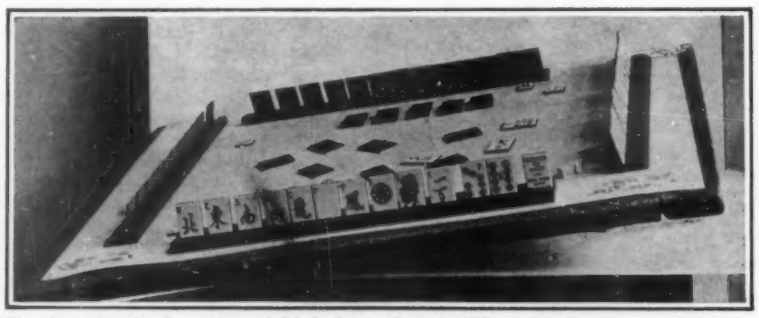
Cutting Glass with a Machine

LARGE mills sheets of glass have always been cut up into smaller sizes by hand, with much expenditure of time and with unsatisfactory results. It has been necessary to score the glass with the cutter on one side, and then break it; under this treatment there is always the risk that the under, unscored edge will crumble, or even that the whole sheet will crack. The gaging has presented difficulties, too, an allowance over the gage reading of from an eighth to a quarter inch having been necessary.

A Newark manufacturer now offers a machine for cutting glass, based upon the new principle of scoring it on both sides. This calls for two cutting arms, two cutters, and a spring-held adjusting nut for insuring even pressure against both sides of the sheet, as well as for separating the cutters for insertion and removal of the work. Breakage is eliminated, as the sheet thus scored at identical lines on both sides comes apart at once and cleanly; while the gage works to its true readings, without allowances. Finally, it is claimed that owing to the better regulated and even pressure on them, the cutter wheels used on the machine have from five to ten times the life of those used by hand.



Thick heavy Chinese tiles of bone and bamboo, compared to the American wafer-like tiles



The Americanized version of Mah Jong played with wafer-like tiles and handy racks. This game can be played anywhere, even in the swaying boat or train

Half Pepper, Half Salt

THIS glass shaker for table use contains salt and pepper. To the left of the notch is the pepper chamber, to the right the salt. In the cap, which is divided into two sections, are corresponding large and small holes. One is closed while using the other. A mix-up is avoided when filling containers by the use of a paper cap which fits either side of the glass division. In a picnic basket, salt and pepper will not stray, but remain in the shaker.

Marking the Stolen Car Beyond Mistake

THE advent of the automobile has built up an enormous field, previously non-existent, for inventive ingenuity. Certain simple needs of the motorist have yet to be met, however, in spite of the amount of time and white paper that has been used up in trying to meet them. One of the things that we have not yet seen is a really simple, really adequate, preventive of theft of the car. Mr. Jeus Nelson of Los Angeles shows us, however, an unusually clever attack upon this problem; and unlike the majority of clever inventions in this particular direction, it is decidedly simple in operation and, apparently, would certainly betray the fact that a car had been stolen, if it did not actually lead the thief to try his luck with another vehicle.

Mr. Nelson would build the license plate in two stories, with the first three digits (or less, or on some New York cars more) in the upper row and the last three in the bottom line. He would thus have a sheet of metal large enough to enable him to cut out, from its center, a circular or rectangular piece of such size that its absence would surely be noticed. This removable piece would screw in by a simple thumb-screw device; and in this connection it ought to be pointed out that the difficulty of detaching a screw that has been in the plate for 365 days does not measure the ease with which the screw would come out if its removal were frequent. We know lots of people who remove distributor arms, coil boxes, etc., from their cars when leaving them unattended; we can't see why Mr. Nelson's procedure isn't just as easy. His only barrier, apparently, is the necessity of selling his idea to state licensing bodies rather than to the individual user.

Theft-proof license plate—when you leave the car you take a piece of it with you

Specifications for Electrical Instruments

UNFORTUNATELY, national standard specifications have been better appreciated abroad than in the United States. In the case of electrical measuring instruments, for instance, British specifications were adopted in 1909; French in 1921; and German in 1922.

Realizing the benefits which would result from national specifications for electrical measuring instruments in the United States, the Bureau of Standards has been striving to get consideration for the subject in this country. It has translated the French and German specifications and sent copies of them, together with the British specifications, to American makers and large users of electrical instruments.

In cooperation with the Instruments and Measurements Committee of the American Institute of Electrical Engineers, a personal canvass of the instrument makers of America has been made. The results of this canvass show that a majority of the makers are in favor of standard specifications and indicate the desirability of having tentative specifications prepared to serve as the basis for further discussion. Such a tentative specification was prepared and presented last June. Further progress in the development of American standard specifications will be based on the comments and suggestions which will be received from instrument makers and users.

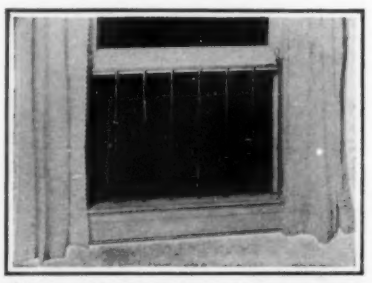
The Adjustment of Automobile Headlights

THE necessity for improved motor vehicle headlights is generally recognized, and the Illuminating Engineering Society has developed satisfactory methods of test and has obtained a great deal of data on candle-power requirements and distribution. These I. E. S. specifications, as they are called, have been approved by the Society of Automotive Engineers for regulatory purposes. However, even the best device obtainable will not be satisfactory to either driver or pedestrian unless properly adjusted.

To help in educating the motoring public to the necessity and advantages of proper headlight adjustment, the Bureau of Standards has assigned an engineer to work principally on this one problem. The Bureau intends to cooperate actively with all agencies interested in securing improvement in headlighting.

A Disappearing Window-Guard

AN interesting window-guard is offered for use with double-hung windows, to prevent ingress of marauders or egress of the baby while the lower sash is up. This guard is attached at the bottom rail to two rods extending upward through grooves in the side rails. It may be detached only from inside the window, by operation of a handle on the top rail. It is so constructed and attached that when the lower sash is closed, the guard is carried down with it, into the space below the sill, and out of sight from without.

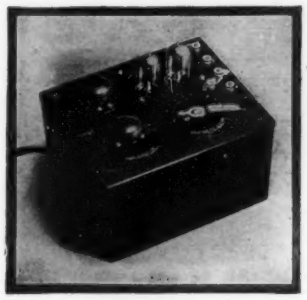


Neat and attractive window guard of recent design, seen from within

There's a Radiola for every purse

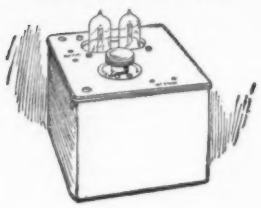
New and Revolutionary Radio Achievements in the new Radiolas

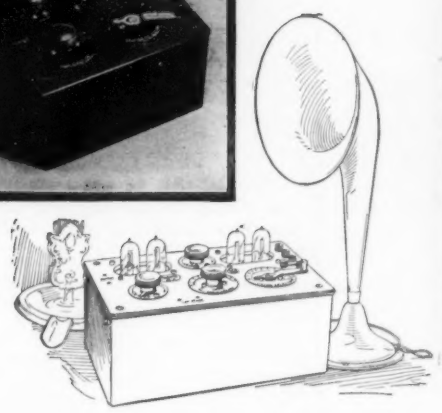
Radiola III, an improved two tube receiver of antenna type, sensitive and selective. *Complete* with two WD-11 Radiotrons and headphones (everything except batteries and antenna) . $35.



Radiola III Amplifier

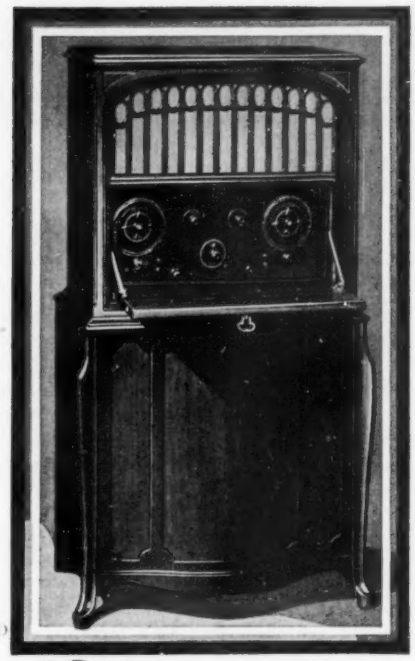
Two tube balanced amplifier for Radiola III, including two Radiotrons WD-11 . $30.



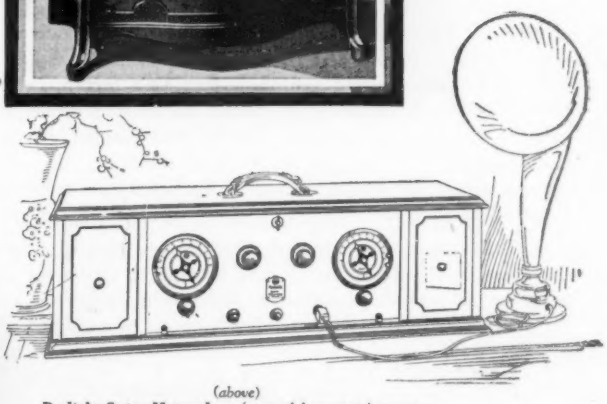


(above)

Radiola III-a, which is Radiola III and its balanced amplifier complete in one cabinet; including four WD-11 Radiotrons, headphones, and Radiola Loudspeaker (either type FH or UZ 1320.) Everything except antenna and batteries . . . $100.



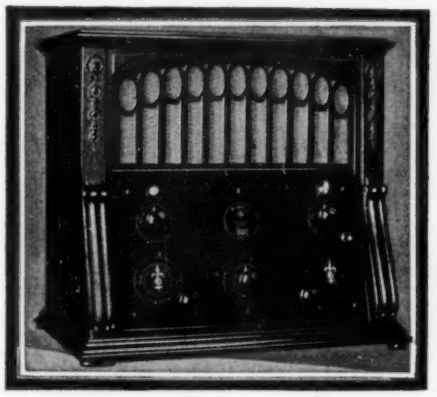
Radiola Super-VIII —an improved Super-Heterodyne. Selective and non-radiating. With *no antenna*, and no ground connection, it receives far distant stations, even while local ones are operating. Loudspeaker built in. *Complete* with six UV-199 Radiotrons—everything except batteries. $425.



(above)

Radiola Super-Heterodyne (second harmonic) same as Super VIII but semi-portable in mahogany finished cabinet, with separate Radiola Loudspeaker of either type, FH or UZ 1320. With six UV 199 Radiotrons, but without batteries . . . . . $286.

Same as above, but without Radiotrons or Loudspeaker, $220.



(above)

Radiola X—ultra refined receiver of the antenna type, selective and non-radiating. Remarkable for distance reception and perfect reproduction. Built-in new type loudspeaker. Complete with four WD-11 Radiotrons—everything except batteries and antenna. $245.

(below)

Radiola Regenoflex, a modified Radiola X, in mahogany cabinet, with external loudspeaker. With four WD-11 Radiotrons and Radiola Loudspeaker (FH or UZ 1320), but less batteries and antenna . . $206.

Same as above, but without Radiotrons and Loudspeaker, batteries or antenna . $150.

$35	$206
65	220
100	245
150	286
$425	

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Radiola

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Marshaling the Telephone Forces

In the simple act of lifting the telephone receiver from its hook every subscriber becomes the marshal of an army. At his service, as he needs them, a quarter of a million men and women are organized in the Bell System. One skilled corps of the telephone army moves to place him in talking connection with his neighbor in the next block, in the next state or across the continent. Another highly trained corps is on duty to keep the wires in condition to vibrate with his words. Still others are developing better apparatus and methods, manufacturing and adding new equipment, and installing new telephones to increase the subscriber's realm of command

The terrain of the telephone army is the whole United States, dotted with 14,000,000 instruments, all within range of the subscriber's telephone voice. Even in the remote places this army provides equipment and supplies. Its methods of operation are constantly being improved, that each user may talk to his friends with increased efficiency. Millions of money are spent in its permanent works. Yet its costs of operation are studiously held to the minimum, that the subscriber may continue to receive the cheapest as well as the best telephone service in the world.

The permanent objective of the Bell System army is to meet the telephone needs of the nation—a hopeless task were not its command unified, its equipment adequately maintained and its personnel trained in the latest developments of telephone art.

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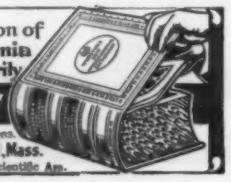

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Automotive

Some Surprising Results were the outcome of tests made by a British motor truck operating company on a number of lubricating oils in service. The tests were an effort to find out whether or not it is good policy to buy an expensive oil for commercial work. After the tests it was given out that the oil that cost the least and gave satisfactory results would be the best oil to use. The method adopted for testing was straight use in a new or recently overhauled engine on a vehicle in ordinary everyday work. The engines were run for six months, covering up to 24,000 miles. Every effort was made to prevent setting up unusually ideal conditions for the tests—the oils were used as oils are used in commercial vehicles where ideal conditions are not usually attainable. It was found that as a result of crankcase dilution, the oil viscosity generally drops during the first two months, and then remains practically constant. It is also stated that there was no necessary relation established between flash-point and volatility. An oil having a high evaporation value would be uneconomical in use. The condition of the crankcase was found to be much cleaner when aluminum pistons were used, as these keep cooler than cast iron and thus do not coke the oil on their under side. Statements are frequently made to the effect that certain brands of oil, owing to their superior friction-reducing qualities, will enable a higher mileage to be covered per gallon of fuel. From the records of the seven oils tested there would appear to be very little if anything in the argument for commercial work.—*Automotive Ind.*, 50:1, 3 pp.

The Epicyclic, Two-Speed Drive, similar in some respects to that used on the Ford car, has been adapted to the stock models of a prominent German car. The epicyclic gearing is brought into play by means of brake shoes which expand against one or other of two drums, the braking effect being internal expanding instead of external contracting.—*The Autocar*, 51:1465, 1p., ill.

Pink Gasoline may replace the water-white in use today if the public can be educated out of the whim for white "gas." The idea is not exactly a novel one to the oil refiner, for even now the gasoline exported to certain countries must be conspicuously colored; also during the war the army and navy adopted a somewhat similar scheme for identifying the "fighting grade" of aviation fuel. A predominating proportion of gasoline, however, is refined water-white simply because the great automobile-driving public has been taught to accept no other grade. This is not the result of a deliberate educational campaign on the part of the petroleum industry; rather it is a condition more or less forced on that industry by competition. The public associates color with impurity, and the easiest way out for the oil industry was to call on the chemist and chemical engineer to take out the color. The desired result has been attained remarkably well, even though the process has undoubtedly added something to the cost of the product and at the same time actually lessened its performance value. In order to satisfy this whim of the public for water-white gasoline, the petroleum refiner has consented to make the sacrifice.—*Chem. and Metall. Eng.*, 29:27.

Last Year's Progress in Automotive Design as shown at the New York automobile show: The new high-turbulence type of combustion chamber is actually resulting in higher mean effective pressures. The increased rapidity of combustion has resulted in materially advancing the peak of the expansion curve. Mean effective pressures of 100 pounds per square inch are becoming common in passenger car practice, and the high-turbulence combustion chamber is responsible for this in no small degree. Nearly every new engine brought out during the past year has had this feature included in its design. In all the new cars a real effort has been made to make the passages uniform between the carbureter and the cylinder. Instead of easy bends and curves in the manifold, which tend to allow the globules in the mixture to segregate and deposit on the walls, square sections and abrupt turns are being used to agitate the mixture and thus to keep the fuel globules in suspension. Turbulence in the manifold is regarded as important, just as it is in the combustion chamber, but for a different reason. In the manifold it is to keep the charge in suspension, while in the combustion chamber it is to increase the rapidity of combustion. Higher outputs without unreasonable compression ratios have been secured by a combination of better manifolding or distribution, better combustion-chamber shapes, reduced frictional horsepower, better balance, lighter reciprocating parts, larger valves, and a wealth of small refinements. The engines are more sightly because of the cleaning up of the exterior. Finally, engines are much more durable, because of greater bearing areas, the lighter stresses, and better materials.—*Automotive Ind.*, 50:2, 3 pp., ill.

Civil Engineering

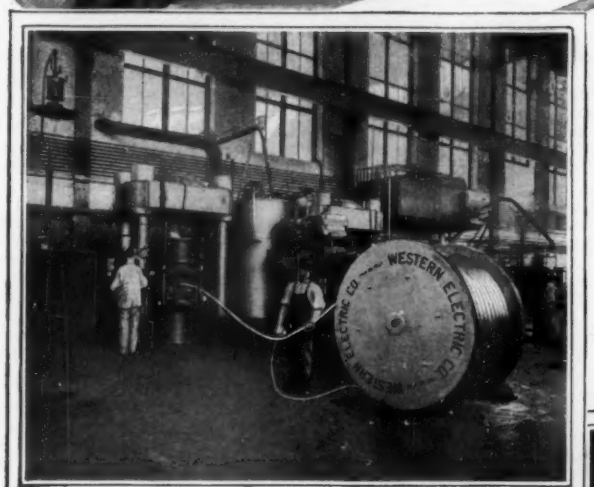
An Experimental Rubber Pavement laid in Singapore has stood up in remarkable condition against heavy traffic. The space used for the roadway test is 30 by 15 feet (50 square yards), and the paving was put down July 6, 1922. The blocks are 9 inches long, 3 inches wide, and 3¼ inches deep, and are formed of a hard basic compound with about three-eighths of an inch of rubber capping directly vulcanized on the three-inch width of face, and without iron clamps or other mechanical attachments. They are laid on a six-inch concrete cement base, and the test area is inclosed with granite blocks. Up to the end of November, 1923, it is estimated that fully 300,000 tons of loaded and unloaded motor lorries, wagons, bullock carts, and passenger automobiles passed over the rubber pavement, yet close examination revealed practically no wear. In only a couple of spots was any movement of the surface remarked, and that was a trifling forward creeping, due probably to a slight pressure from the granite curbing. Signs of slipping or skidding were lacking, even though the pavement is subjected to fast and slow-moving traffic, and heavily laden lorries and wagons pull up and restart upon it. The roadway is exposed to the full rays of the sun, and the rubber area has had no special treatment since being laid.—*India Rubber World*, 69:4, ½ p.

The Building of a Railroad Across the Sahara has been approved by the French government and the only thing that now stands in the way of the actual accomplishment of the project is the formulation of a law by the chamber of deputies. It is expected that building of the trans-Saharan railroad will take seven or eight years. It will connect Oran, in French Morocco, with Wagadugu, capital of the province of High Volta, near the Gold Coast. Stretching from the Mediterranean to the Niger, passing directly across the immense wastes of the hitherto unconquered deserts, the trans-Saharan line will be an achievement almost as important as the trans-Siberian road. Not only will it be a work of great strategic importance, by linking up two widely separated parts of French West Africa, but it also will be of vast economic value, facilitating the transportation of exports to Marseilles. An interesting feature of the proposed trans-Saharan railroad is that for the most of the distance of 1750 miles it will be necessary to run pipe lines or maintain a conduit system of some sort, connecting with deep artesian wells, to insure an ever available water supply. France will gain direct and easy access to a realm in west central Africa with riches hardly touched at present.

(*Continued on page 188*)

Then, a tug of war— now, a "reel" job

HEAVE, HO! In the old days, from eight to sixteen men were needed in the factory to pull a single telephone cable core into lead pipes—which, soldered together, formed the sheath. A slow and laborious task.



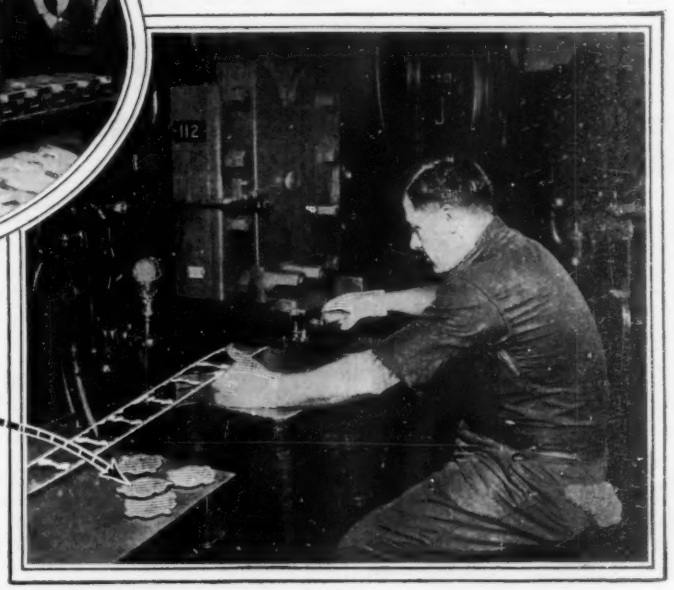
HOW IT'S DONE TODAY. Now two men can operate the machinery which applies molten lead to the cable core to form a continuous covering. These two men cover more cable than the sixteen did the old way—and what's more, they do it better.

THE pictures show the old and the new way, as applied to two manufacturing processes of many thousands in our factory.

Better work, quicker work, and yet with fewer men needed for each job—progress like this marks the history of Western Electric as a maker of telephones.

Improvements of this kind have made possible lower costs of manufacture and vastly increased production, and here you have two reasons for the vast number of telephones in the United States—more than in all the rest of the world.

MOLDING TRANSMITTER FACES the old way. The brass (nickel-plated) face of the telephone transmitter was made as a casting. Another case of many men producing a small output—with much of it failing to meet the high standard required.



THE TRANSMITTER FACE TODAY. Now it is punched out of a brass strip. One man produces more than the crew of yesterday, and with a far higher percentage of perfect pieces.

Western Electric

SINCE 1869 MAKERS OF ELECTRICAL EQUIPMENT

When the Wrecker Comes

Powerful steel cables soon clear the way for traffic. They roll the badly damaged equipment to one side and lift the balance back on to the tracks.

It's grueling work that calls upon every ounce of strength and stamina the cables possess.

In Yellow Strand Wire Rope these qualities are found in generous quantity. The *Strand of Yellow* is the maker's mark that prevents you from using a weaker rope when Yellow Strand strength is demanded.

All standard grades of wire rope, for all purposes, are made by the makers of Yellow Strand. Specify them.

Motorists
Carry a Basline Autowline in your car and safeguard your spare tire with Powersteel Autowlock. Both are made of Yellow Strand. Ask your accessory dealer.

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MARINE MOTOR

GRITTY, smooth, four-cylinder power—with sparkle and pep to its work! Truly, Universal adds much to the sport of boating. New 1924 model embodies eight refinements which makes it, more than ever, "world's standard for boats under 30 feet." Eight variations of assembly to choose from. Send for catalog, mentioning kind and size of boat you are figuring on.

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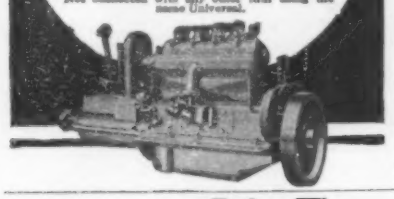

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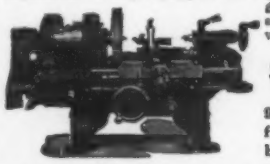

$270
9" lathe—2½ ft. bed—with bench legs

Also built with bed lengths up to 5 feet. Made in 11-inch swing size too, at slightly higher price.

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Boice Pony Bench Saw
Sold with or without motor

The Boice Pony Bench Saw shown here is a compact, low-cost precision machine of all metal construction. Saws 1½" stock. Dadoes ⅜" x ½". Easily driven by ¼ or ⅓ h.p. motor. Top 10" x 12". Attaches to any light socket. Sold on guarantee of satisfaction or money refunded.

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Scientific American Digest

(*Continued from page 186*)

The ministry of colonies foresees the possibility of converting a dry but fertile area of approximately three-quarter million square miles into fruitful regions, ranking with the valleys of the Nile or the Euphrates. This vast extent of virgin land is looked upon as a potential granary for France, making her, with the aid of her colonies, self-sufficient in all respects. Three problems face the railroad companies to be formed. One is the menace of bandits, which the government believes can be easily solved. The second and third difficulties are sand storms and torrential rains, which occur at regular periods. —*Railway Rev.*

Regenerative Braking Tests of an electric locomotive were made at Erie, Pa., for the Mexican Railway. The electric was pulled by a mikado type steam locomotive, equipped with booster, superheater and all other improvements, and operated by a picked crew. During this test the electric locomotive, connected to send power back to the line, was hauled by the steam unit at a speed of about 14 miles per hour, the steam unit operating at full capacity. As high as 1800 horsepower was sent back into the electrical system at one part of the test.—*Railway Rev.*, 73:24, 1 p.

Saving a Concrete Road.—A method of resurfacing concrete roads which have become worn by constant and heavy traffic, and which may claim the attention of engineers, is described in *Mfrs. Record.* In 1918 the road from Humble to Moonshine Hill in the heart of the Humble Oil Field, Texas, was paved with concrete. This road is subjected to the usual heavy oil field traffic and by the summer of 1920 showed such rapid wear that the county commissioners decided that it was necessary to resurface the road immediately. Sufficient funds to apply a two-inch hot mix bituminous surface were not available and it was necessary to lay something cheaper. Inverted penetration using trap rock and Texaco No. 250 asphalt was selected. The road was swept clean and one-half gallon of asphalt per square yard was applied with a pressure distributor. The asphalt used is a very soft grade, having a penetration of 250 to 300 at 77 degrees Fahrenheit. It adheres to concrete perfectly, especially when the surface has been roughened by traffic. The asphalt, while still hot, was covered with trap rock one inch to one-quarter inch in size, a cubic yard of stone covering approximately forty-five square yards. The surface was then rolled lightly to set the stone in the asphalt and immediately open to traffic. The road has been subjected to very heavy traffic for three years since this surfacing was applied and now is in excellent condition, as is clearly shown by a photograph taken three years after the completion of the surfacing job. The surfacing has adhered to the concrete perfectly and there has been no sign of shoving, rolling or rutting. This method of resurfacing a concrete road is recommended where sufficient funds for laying a hot mix bituminous surface are not available.

Electrical

Centralized Combustion Control has been developed to govern boiler plant operation electrically. In one system described in *Power* (59:2), as applied to stoker-fired boilers, the forced draft fans, stokers and induced-draft fans are driven with direct-current motors. The speed of these motors is controlled by an exciter motor-generator set, the voltage of which is adjusted from a master regulator which gives the initial impulse. If an increased load is thrown on the turbine this will cause an increased demand for steam and a drop in the steam pressure, which will cause the master regulator to operate and move in a direction to cut resistance into the field circuits of the exciter generators, thus causing the voltage of these machines to be reduced. The reduced voltage applied to the field of the stoker and fan motors weakens their field and causes them to speed up to supply the proper amount of fuel and air to carry the new load. On the other hand, a reduced load on the turbine causes opposite effects. Thus the master regulator causes the whole boiler plant to respond automatically to the load.

The Inter-Scandinavian Power Project has been reported on by a commission appointed by the governments of Denmark, Sweden and Norway. It is believed that within ten or fifteen years the power demand in Denmark will probably reach 500,000 kilowatt-hours a year. Power would be transmitted directly from Norway to Denmark through an 80-mile cable in Skagerack. The plan calls for three single-conductor cables, each insulated for 110,000 volts to sheath. One of these would be a reserve cable, although normally running in parallel with one of the others. If three-phase transmission were used from Norway to Denmark, a 132,000-volt line would be erected along the Swedish coast down to Helsingborg, on the Straits of Oresund. Since at present cables cannot be operated safely above 50,000 volts, it would be necessary to step down to this voltage before crossing to Denmark. An alternate scheme therefore has been worked out, calling for an aerial crossing 200 feet high as a minimum over the Straits. Two spans would be needed, each 7500 feet long and carried on 650-foot high steel towers. The conductors would be 240 square millimeters (475,000 circular miles) extra high-quality steel. — *Elect. World*, 82:19, 2 pp., ill.

Forty Lighting Intensities in One Street is the experimental answer given in tangible form by the city of Cleveland to the unsettled question as to how much light and how disposed constitutes good street lighting. Forty separate lamp circuits were set up in a 2000-foot section of a typical Cleveland street, each circuit illustrating a definite principle of correct illumination. In a lighting sense, this constitutes virtually 40 streets in one. Lamps ranging from 100 candlepower to 3000 candlepower in size, with spacings from 75 feet to 900 feet are mounted at heights from 11 feet to 26 feet. The location of the units ranges, by four successive steps, from two feet back of the curb line to the center of the street, bracket arms being used. This is the only place in the world where an instant comparison of a wide variety of lighting effects upon the streets can be made. One purpose of this unique installation is to afford a ready means for study of lighting effects under a variety of conditions, with a view to obtaining some clear, definite information on the value of each system. Another use, however, is brought out when a town or village wishes to select a suitable street lighting system. Generally this has had to be done without proper opportunity to study the actual installations in the very comparative sense afforded only by having them all set up in a single street and being able to shift from one to the other and back again within so short a space of time that a really accurate comparison can be made and the large element of personal equation, heretofore existent, practically eliminated.—*Elect. World*, 82:22, 1 p., ill.

The Factory of the Ford Motor Co. at Green Island, N. Y., is heated by hot water which is heated by electricity. The building is 1140 feet long, 120 feet wide and consists of three bays, the two side bays being about 20 feet in height and the central bay about 35 feet in height. The outer exposure of this building consists of about 60 per cent of glass; 65,000 square feet of radiation is installed. Water is circulated by motor-driven centrifugal pumps at the rate of 1500 gallons per minute, at a pressure of about 40 pounds. The water is circulated through one or two electric heaters, depending upon weather conditions, and is raised to temperature from 135 to about 153 degrees Fahrenheit. The heaters are of the electrode or water-resistance type, having a capacity of 3200 kilowatts each, and are operated at 4600 volts three-phase 60 cycles. The advantages of electric heating are cleanliness, minimum of space required and high efficiency. No separate heating plant is required, no fuel storage, ash handling or labor. The heaters require only occasional attention by a janitor or other attendant.—*Power*, 59:2, ½ page, ill.

London, as well as most of the cities of Great Britain, is almost entirely lighted by gas, according to a writer in *Electrical World* (82:21), and excellent gas lighting it is. The one drawback to the wider and more intensive use of electricity there is the lack of standardization. The Britisher recognizes that there should be regularity in the sizes of hats, collars, screws and nuts, but when it comes to the voltage and frequency of his electric supply, he has thus far evinced no interest. Confronted with almost as many varieties as a dog has fleas, the manufacturer is also in a dilemma. Big production is out of the question; distribution of supplies is difficult; stocks are as numerous as the stars, so that costs must necessarily be higher. In the area of Greater London alone there are some 70 generating stations, representing between them 50 dif-

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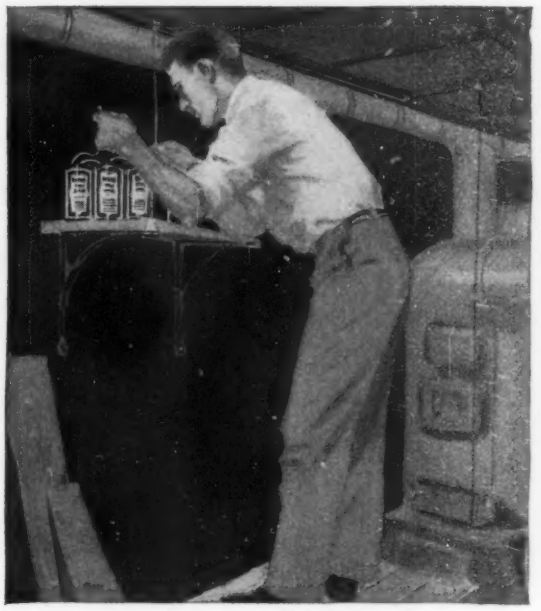
ferent systems of supply, 24 different voltages and 10 different frequencies. The average price of current in 14 London municipally owned plants varies from 3.86 to 10.58 cents per kilowatt-hour; 14 private plants in the same city receive payment at from 3.04 to 11.9 cents.

General

The Inability of the German Steel Industry to Reenter World Markets on its former scale in the near future will be particularly marked, if the French, in order to provide reparation funds or for other purposes, decide to enforce special export or import duties, coal taxes, or other forms of taxation in industry and if the existing customs barrier between occupied and unoccupied Germany is continued. The coal, coke and metallurgical production of the Ruhr and the finishing industries and food-providing regions of unoccupied Germany, the commercial attaché pointed out, constitute a natural economic unit whose sudden separation is likely to mean depression, higher production costs and general inefficiency. At one time it was believed that the long cessation of steel exports from the Ruhr, due to the embargo and other incidents of the occupation, would result in heavy dumping when passive resistance was abandoned and in embarrassment to our own export trade. Long before passive resistance was given up it became apparent, however, that the great reduction in normal output, due to transport paralysis and other causes, and the volume of prior orders which could not be filled after the embargo became effective in January of this year, would greatly limit the stocks available for dumping abroad. The possibility of dumping and breaking world prices has been further discounted by the lien which the occupation authorities have maintained on finished steel stocks pending the settlement of tax, coal delivery and other questions.—*Iron Age*, 112:25, ½ p.

The Old Style of Balloon Shaped Carboy packed in hay, formerly used for shipping acids, has passed out of existence, according to a manufacturer of chemical glassware. In its place we have the straight side carboy cushioned within the box entirely with wood. This change was necessitated on account of the excessive breaking with the old style carboy and frequent fires arising from nitric acid coming into contact with combustible packing material. The straight side carboy is much stronger than the balloon shape and can be more readily cushioned with wooden braces. There have been several designs of carboy cushioning used in recent years, but the severe tests to which they must be subjected to meet the specifications of the Bureau of Explosives has eliminated most of them. The severity of these tests will be appreciated when it is explained that one test, called the drop test, requires the carboy to be filled with water and then dropped from a height of 16 inches squarely onto a concrete floor without breaking. The other test, called the swing test, requires the carboy filled with water to be suspended from a point 14 feet high and allowed to swing squarely against a solid concrete wall from a horizontal distance of 55 inches without breaking.—*Brass World*.

Another German Invasion of the Chemical Industries is anticipated by *Chem. and Metall. Eng.* (Vol. 29, No. 25), in an editorial in which it is stated that "The fall of Stresemann, if we can place reliance on reports that come to us from Germany, may prove to be the signal for the German chemical manufacturers to abandon all hope of continuing their operations in Germany. This does not mean that all chemical activities will be transplanted, lock, stock and barrel, to other countries. It does mean, in the opinion of experienced observers, the beginning of the migration. Ever since the armistice delegations of German traders and financial men have been visiting this country. Lately some of the foremost of the German industry's technical experts have been inspecting our centers of chemical industry, as well as our water-power developments. Sometimes the missions of these men have been satisfactorily explained; at other times suspicion might easily be attached to their movements. At any event it is not likely that negotiations for the purchase of plants in this country or the establishing of manufacturing subsidiaries will be made known to the general public. Such a procedure is not in keeping with methods used by the German industry in this country prior to the war, nor with those that have resulted in the German control of various French and Italian chemical industries.



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Rather the invasion would be of the nature of a peaceful penetration. By buying into some of the weaker chemical plants and gradually expanding operations it would be entirely possible for the Germans to obtain a strong foothold in this country before it would become generally known even to those in closest touch with the industry."

Shooting Oil Wells is now comparatively safe. In the past, liquid nitroglycerin was the explosive most commonly used for this purpose. Because of its extreme sensitiveness to friction, impact, and heat, it is easily exploded. This, since it permits a simple method of detonation, is desirable for oil-well shooting; but its sensitiveness also makes liquid nitroglycerin an extremely dangerous explosive to handle, and each year it exacts a large toll in lives. Of late there has been developed a type of high-grade gelatin which is particularly adapted for deep-well shooting. Results, equal in every respect to those secured with liquid nitroglycerin, can now be obtained with *torpedo gelatin*, a product that is plastic and can be readily and firmly packed into the torpedo shells. Torpedo gelatin is an explosive, and, of course, must be treated as such; one should always remember that its purpose is to explode. It is, however, much safer to handle than liquid nitroglycerin and it may be transported by any public carrier in accordance with I. C. C. regulations.—*Explosives Eng.*, 1:8.

Smuggling has become a regular business. It has reached a point where boats engaged in that activity have arranged for return cargoes. Tobacco and other commodities subject to import duties and excise taxes in other countries are carried back and, in turn, are smuggled into those markets. The smuggling began as a side line in connection with the illicit traffic in alcoholic beverages. It is still being conducted in connection with liquor running, but the side line has become a much more important part of the undertaking. In many instances it is known to be more profitable to import certain concentrated chemicals and special pharmaceuticals than it is to bring in whiskey. The rum runners have blazed the path for a renewal of smuggling operations of a general character on a wide scale, according to customs officials in Washington, and a number of smugglers find it more profitable to handle drugs and chemicals, jewelry and fine laces than to handle whiskey.—*Chem. and Metall. Eng.*, 29:27, note.

Industrial Progress

Methods by Which Enormous Volumes of gasoline now lost in ordinary petroleum refining processes may be recovered by the condensation of still vapors are outlined in detail by the Bureau of Mines in Technical Paper 310. At 13 refineries from which data were collected 128,651 gallons of gasoline, representing an average increased recovery of nearly half a gallon of gasoline per barrel of crude oil, were being recovered daily from uncondensed vapors. The figures represent the increased conversion into gasoline of 1.05 per cent of the crude oil charged, which would otherwise have been lost. Losses of gasoline from uncondensed still vapors will tend to become larger in the future, the Bureau of Mines points out, because the growing tendency to eliminate evaporation losses in handling crude oil in the field will result in refineries receiving crudes containing much lighter and more volatile fractions. The magnitude of the losses resulting from non-condensation of still vapors has been realized by only a small proportion of the refiners and comparatively few plants have installed recovery systems.

A New Instrument for Showing the True Body of Oils has been developed. When an oil is rated by the time it takes for a given quantity to flow through an orifice under the influence of a gravity head, the density of the oil at the temperature of testing has considerable influence upon the result, so that when the oil is diluted by gasoline, as is usually the case, and the weight of a unit volume is less, an error is introduced. The new instrument is of the "cup and ball" type and the viscosity measurement depends upon the time taken for a very small quantity of oil to flow between the cup and a steel ball which is initially pressed into the cup. The whole apparatus is preferably immersed in a bath of the oil to be tested; a thermometer is inserted in the handle of the cup and the temperature is raised. When equilibrium is reached at, say, 210 degrees Fahrenheit, the ball lying at the bottom of the bath, the cup is pressed over it, care being taken that no air is en-

(*Continued on page 192*)

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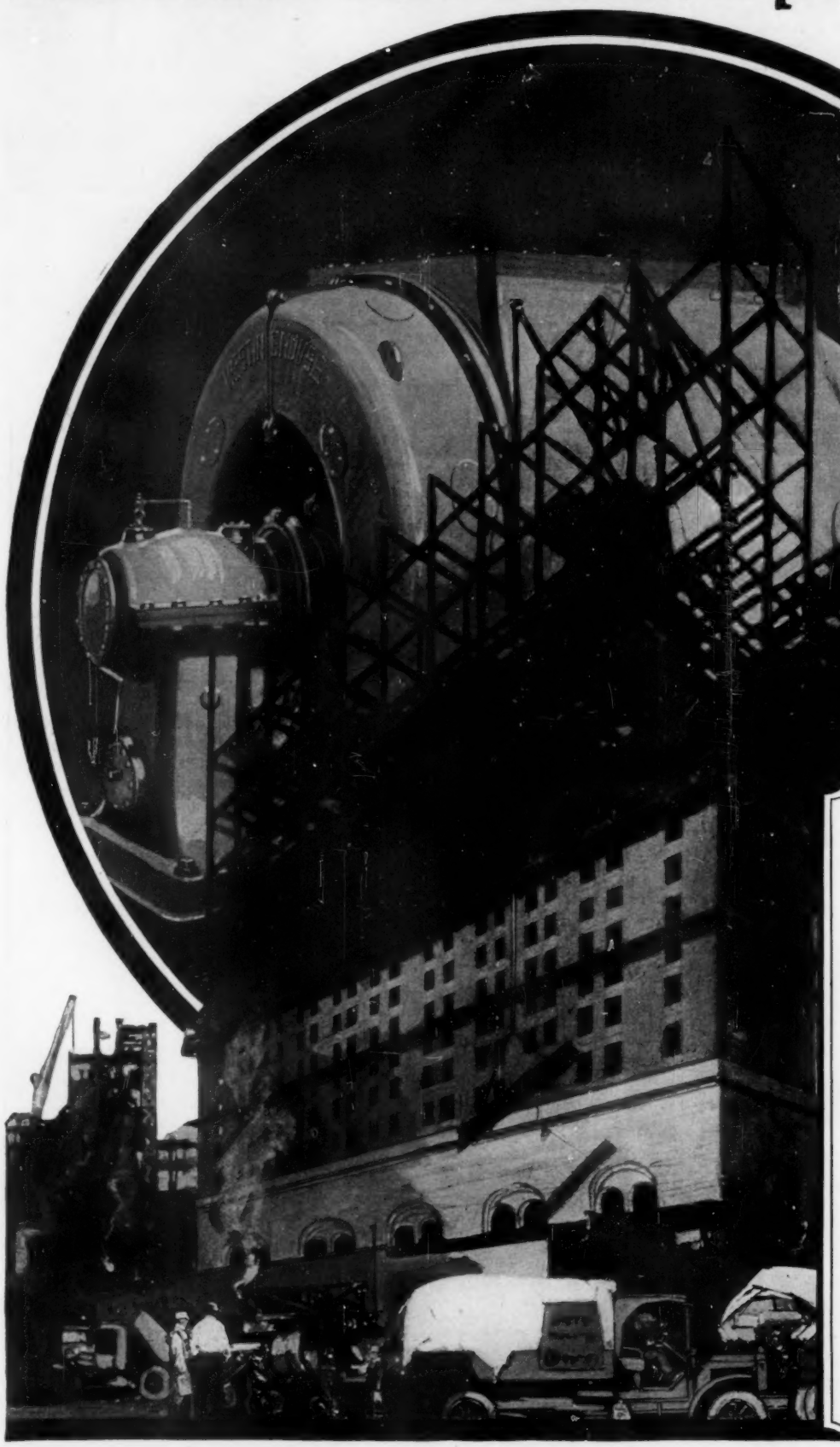

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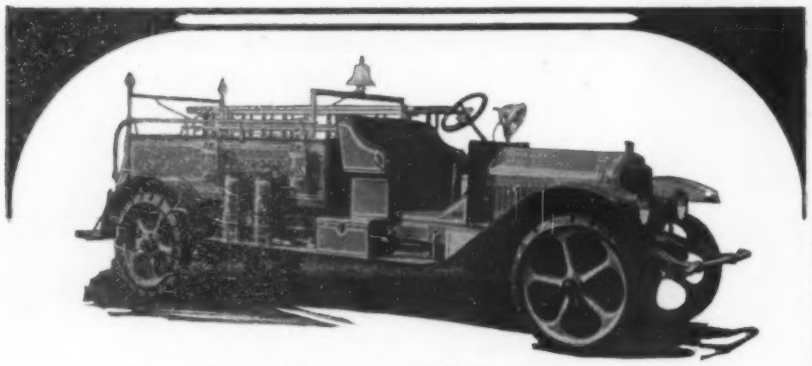

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Dayton
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Scientific American Digest

(*Continued from page 190*)

trapped. The handle of the cup is then raised, carrying the ball just clear of the bottom of the bath, and the time is noted by a stop watch. The ball will drop as soon as a film of oil has crept between it and the cup, and the time taken for this action, in seconds, divided by a constant, gives the actual value of the body of the oil.—*Automotive Ind.*, 49:25, 2 pp., ill.

Using the Waste Heat in Coke.—In all gas works the output of gas results in the production of coke, which leaves the retorts in an incandescent condition. The heat in the coke has invariably been wasted, but efforts have been repeatedly made to utilize a considerable portion of it. It would be a great achievement if the whole of the heat could be used; it would be available, for instance, for heating water for industries requiring hot water daily, the year around, such as large laundries. It has been hitherto the usual practice to quench this incandescent coke with sprays of water, resulting, as is well known, in a loss of approximately 630 British thermal units of potential heat per pound of coke cooled. Means have recently been devised for obviating the tremendous waste of potential heat and from results which have been yielded by a test plant built on an industrial scale it has been shown quite definitely that a quantity of from 800 pounds to 900 pounds of steam at 100 pounds per square inch pressure can be produced per ton of incandescent coke cooled. The most recent advance has been made in Europe, where incandescent coke is now cooled in several ways on a large scale. An experimental plant has been constructed in a Swiss gas works. The results obtained have been considered so satisfactory that a number of other similar plants are being installed and more are under consideration.—*Am. Gas Jour.*, 119:28, 1 p.

A New Foundry Wrinkle.—The foundry is pushing its neighbor, the machine shop, close in the manner it is adapting compressed air equipment to its various activities. A new use for air has been found at a Cleveland plant where it is employed to remove the cores from automobile cylinder castings. The shakeout machine in effect is a combined vise and vibrator. The vise holds the casting and the vibrator agitates it to such an extent that all the core sand disintegrates and runs through the opening in the crankcase, through the opening between the two side members of the machine and on to the conveyor leading to the waste sand disposal tank. The molding sand adhering to the outside of the casting is dislodged at the same time and falls on to the same conveyor. The frame of the machine is a one-piece steel casting and is bolted to anchor bolts in the floor. It is provided on the upper or working side with the following features: Two powerful coil steel springs to absorb the shock while the vibrator is in action; a suitable frame bolted to the frame to support the weight of the casting; a combined ram and vibrator which pushes the casting hard against the coil springs and then shakes the sand out of it; an air cylinder which operates the plunger attached to the combined ram and vibrator. Approximately six seconds is sufficient to remove all the core sand from a cylinder block.—*The Foundry*, 51:24, 2 pp., ill.

A New Cupola Which Preheats the Blast.—It has remained for European practice to take the lead in the use of this principle in the common cupola furnace. The type of cupola invented by E. Schurmann, Dresden, Germany, is the first to be used in this country. This furnace was completed and placed in service early in October, and has been in continuous service since that time. The advantage claimed for the cupola in practice are the saving in coke, a reduction in the sulfur content, and a greater toughness in the iron melted. The user states that the test pieces poured from metal melted in this cupola are much tougher than those from the standard type cupola. A saving of from 20 to 25 per cent in the amount of coke required to melt a given quantity of iron is reported. The sulfur is said to be about two points lower in the iron when it comes from the cupola than when it was charged. The analysis of the entering charge shows 0.175 per cent sulfur. It is said the metal shows a sulfur content of 0.155 per cent when the metal is taken from the cupola. The melting speed of the Schuermann cupola is about 60 to 70 per cent of another cupola the same size in use in the foundry in which the initial American installation was made.—*The Foundry*, 51:24, 3 pp., ill.

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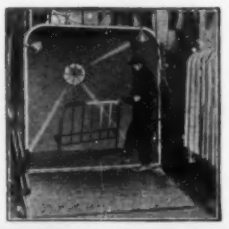

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A Process for Fixing Free Nitrogen is being perfected by the Fixed Nitrogen Laboratory of the Department of Agriculture, according to the annual report of its director. One of the most important steps in any process is the development of a catalyzer whose purpose is to aid in the chemical reaction which takes place when hydrogen under pressure is combined with the nitrogen of the atmosphere to form ammonia. In this latter compound nitrogen is available for fertilizers. Of the several processes which have been used successfully on a commercial basis the direct synthetic ammonia process is apparently the most promising one. The problem involved in the synthetic ammonia process may be divided into two groups, first those which concern the process of making the hydrogen combine with the nitrogen of the air, and, second, those which concern the process for manufacturing and purifying the hydrogen-nitrogen mixture employed in the process. The nature of the entire process centers about the catalyst, and depends largely upon its characteristics. As far as we have been able to learn, there is no country in the world which has an ammonia catalyst superior to that developed by this laboratory. A method has also been developed for manufacturing this material which gives the necessary chemical control of the product and at the same time makes large-scale production possible. As a consequence we are now in possession of such reliable information concerning at least one type of ammonia catalyst and its manufacture that one of the principal obstacles to the successful operation of such plants as United States nitrate plant No. 1 at Sheffield, Ala., has been removed.

The Instrument Field has been active in its contribution to power-plant progress during the past year. A new steam-flow meter, correcting automatically for variations in steam pressure and temperature, has made its appearance, other meters for the measurement of steam have been improved and simplified, and new combinations, to give other data on the same chart, effected. Among the new developments may be mentioned a combination barometer and vacuum recorder, a hand tachometer fitted with speed-recording mechanism, three new electrical CO_2 meters making use of the variation in thermal conductivity of the flue gases, draft gages of the dial type readable across the boiler room, an instrument for indicating and recording variations in the water level in a boiler under pressure and a variety of other devices, all designed to give the operator some specific information and help him visualize the actual operating conditions.—*Power*, 59:1, 4 pp., ill.

Salt Made from Sea Water is the product of a large California industry. The sea water is taken from San Francisco Bay during periods of maximum high tide, in May, June, July, August, September and October. The sea water enters the works, generally through a slough, into the intake, receiving or tide pond, which is provided with large flood gates that automatically open when the water can run in, and close as the tide ebbs. From the intake pond the sea water is raised by a large paddle-wheel pump and goes through the ponds mentioned, gradually becoming more and more concentrated, until it reaches the crystallizing ponds. It is run into these to a depth of about six inches when it has reached a strength of about 25.5 degrees Baumé, or when crystals of salt begin to form. The industry is on a sound basis, although competition has been keen among producers; conditions are better than they are on the Atlantic coast, where large consignments of salt arrive at irregular intervals from Europe and tend to upset the market. Furthermore, the climatic conditions in those parts of California where the so-called solar evaporation methods are practiced are fairly regular: little or no rain falls between March and October. The total evaporation during a season, from March and through October, aggregates about 30 inches. Harvesting commences about the middle of July, when five to eight inches of salt is found.—*Chem. and Metall. Eng.*, 29:26, 3½ pp., ill.

A New Source of High-Grade Coking Coal will be made available by the discovery of a process for separating small amounts of pure coal from large masses that are impure. The specific gravity of each piece of coal depends upon the quantity of ash present in that piece. Hence, if a separation be made by a "float and sink" method by introducing the coal into a liquid of the desired specific gravity, as for example 1.38, all the coal having a specific gravity less than 1.38 will float and all the coal having

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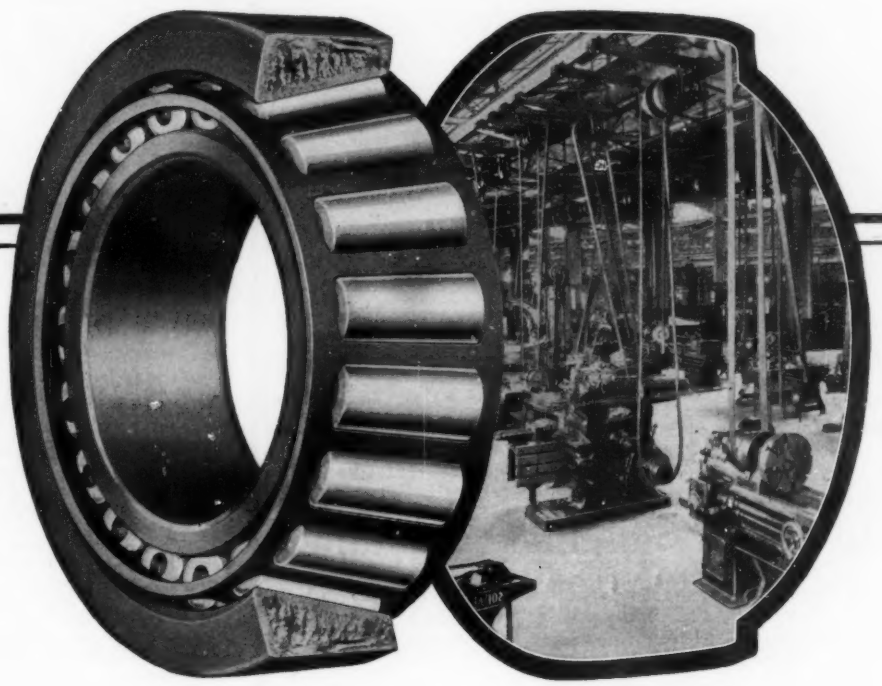

Dual Duty—means capacity to take in one bearing any combination of radial load and end thrust. This advantage, together with perfect adjustability for the wear which inevitably follows motion, has resulted in the equipment of a great and rapidly increasing number of industrial machines with Timken Tapered Roller Bearings.

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Leading manufacturers of Reinforcing Steel, Metal Lath, Steel Windows, Standard Buildings.

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Warehouses and Offices from Pacific to Atlantic.
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Steel Joists, Concrete Road Reinforcement, Steel Stampings, Foundry Flasks, etc.

A Remarkable Improvement in Hack-Saw Blades has been accomplished by an English manufacturer, which, when used in conjunction with a special machine gives six to ten times the usual output per blade. The new blade can be resharpened. It contains 18 per cent of tungsten and it is claimed that it cuts progressively faster and faster after each resharpening. Tests made on the new blades bore out the manufacturer's conservative claims. A long series of cuts were made from a four-inch mild steel bar, using a 12-inch blade, 1¼ inches wide with six teeth per inch, running at 170 r.p.m. While the successive cuts required a longer and longer period of time up to about thirty, when the blade was resharpened it was found that the time needed to make the corresponding cut of each series was shorter and shorter within each series. That is, the saw actually improved with use, provided it was resharpened. The 282d cut was made in 4¾ minutes—less than any preceding one. The average time was seven minutes per cut. In general these blades appear to cut the time required for the present practice about in half, while the output per blade is increased 7.4 times.—*Brass World*, 19:12, 2 pp., ill.

New Interest in an Old Coalfield in North Carolina.—Believing that the Triassic coal of the Deep River field was much more valuable than had been generally considered and that it should become a source of fuel, not only for mills and railroads of Eastern North Carolina, but for domestic use in the form of coke, a geologic investigation was made of this field during 1921 and 1922, by the North Carolina Geological and Economic Survey and the United States Geological Survey. Coal deposits have been known in North Carolina for about 150 years and for many years there has been more or less interest aroused as to the possibility of developing commercial fields of this mineral. Considerable prospecting and some mining has been done during this period, but most of the work was a failure due to several causes, chief of which perhaps was lack of capital and having men unfamiliar with coal mining in charge of operations. As a result the public began to consider that either the coal was so poor or the mining conditions so bad that it was very doubtful if coal mining could ever be made to pay. This was probably a natural sequence considering what was known of some of the coal which was in very thin seams and obviously could not be worked profitably. Also considerable coal that was first used was weathered and did not have the heating properties expected of it. The amount of available coal in this workable field referred to above is estimated by the geologists as approximately 68,000,000 tons of recoverable coal, and that mining can be carried on profitably to a depth of 2000 feet. The area in which this tonnage is included is about 25 square miles, and it is considered reasonable to assume that the coal bed throughout this area averages at least three feet in thickness of recoverable coal.—*Mfrs. Record*, 84:26, 2 pp.

The Year's Contribution to Power-Plant Progress.—During last year all sorts of facts, theories and ideas that have for years lain dormant in textbooks have come to life, demanding immediate recognition. Remarkable openmindedness has been exhibited by the engineering profession toward these "innovations." Whether it be 1200-pound steam pressure, the mercury turbine, or reheating between turbine stages, every suggestion of theoretical merit is being given serious attention. A number of the largest and most recent central-station plants are being equipped to burn pulverized fuel, steel plants are patterning after the River Rouge installation of the Ford com-

(*Continued on page 196*)

Unskilled labor can install Plibrico Furnace Lining. No skilled masons—or their bills—are necessary.

The logic of one-piece furnace walls

SINCE the dawn of history men have built all walls one stone upon another. But today jointless walls of "concrete for permanence" have proved this illogical even in construction work—and in boiler furnaces the brick on brick method is obviously out of the question.

Plibrico, the plastic fire brick, is the logical furnace lining. It comes in metal containers—no loss here by breakage in storage or transit. It is pounded into place by unskilled labor—by any one who can handle a mallet. The first slow heat of the furnace bakes and vitrifies it into a solid, one-piece, rock-like, air-tight lining—makes a huge crucible out of the furnace.

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May we tell you more about this positive furnace economy? Then send the coupon for "Refractories and Furnace Design." Free, of course.

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Please send me the 32-page booklet, "Refractories and Furnace Design"—no obligation.

Firm.....

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Att'n.....

These Engineers Find Fordized Haulage Most Economical

The R. L. Steed Eng. Co., erecting engineers, specializing in the installation and overhauling of power plants in Detroit, use Ford Trucks and Fordson Tractors exclusively for hauling heavy machinery and supplies.

A Ford One-Ton Truck with a big semi-trailer having a 30-ton axle and wheel capacity is used for heavy duty work. Loads ranging from 5 to 22½ tons are carried at an average cost per ton-mile of less than 33 cents. This exceptionally low cost enables this company to give customers a much lower hourly rate than the prevailing charge for larger trucks.

This truck and trailer are shown above with a 9-ton planer, a typical load.

This company is completely Fordized. Superintendents and foremen use a Ford Sedan for rapid transit from one job to another; a fast Ford Model T "pick-up" saves much time delivering tools and supplies; a fleet of three Ford one-ton trucks, equipped with sturdy trailers, and a Fordson Tractor comprise their heavy haulage equipment.

Eight years of satisfactory experience in the use of these dependable units has proved to this company that to Fordize is to economize.

See Authorized Ford Dealers for further facts about this and other examples of Ford operations.

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No device employing strap connections can possibly control both the upward and downward action of the spring. Such devices must not be confused with the Hoo-Dye double-acting, hydraulic shock absorber which absorbs both ecoil and compression by means of a rigid, ball-jointed link. This connecting-rod transmits every axle movement directly to the hydraulic cushions. In no device without such connections or without the marvelous flexible-controlled, non-compressible liquid, as in Hoo-Dyes, can the same comfort and safety be obtained.

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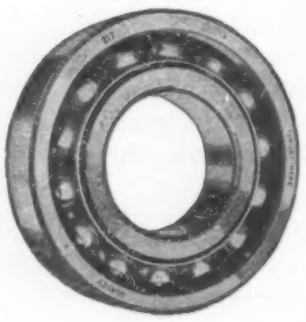

BECAUSE Gurney Bearings mounted according to Gurney Engineering Practice hold machine tool spindles so that they effectively resist the thrust and pull of tools from any direction, controlling displacement, vibration and chatter. They prevent all movement except rotation. Gurney mounted spindles turn with the utmost care and freedom. They offer the utmost rigidity against any other movement.

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402 Chandler St. - Jamestown, N. Y.

GURNEY
BALL BEARINGS

Scientific American Digest

(*Continued from page 194*)

pany and are equipping to burn in combination powdered fuel and blast-furnace gas, a variety of smaller industrial plants have adopted this method of burning coal, and a surprising number of existing plants are trying out one or two boilers with this fuel to determine the system that will fit in best with their particular conditions. One large central station that has been burning fuel oil for several years is trying out powdered coal under one or two boilers. Overproduction due to the ever-increasing demand for gasoline, vast quantities of oil in storage and low prices, summarize the situation in the oil field. The last named factor has stimulated the use of this temporarily cheap fuel in the boiler room and has resulted in numerous changes with profit from coal to oil. Not alone in New England is oil fuel making great headway, but a considerable number of new buildings in New York City as well as in Philadelphia and other sections are adopting it. Its use for heating boilers is also increasing.—*Power*, 59:1, 4 pp., ill.

Breaking Up Large Castings by means of explosives has been hastened by a new and interesting method used in England for boring holes for the explosive charge. A long piece of one-fourth inch external diameter iron pipe is connected to a cylinder of oxygen by means of a flexible tube. The end of the pipe is then heated to a red heat, when the oxygen is slowly turned on. The metal of the pipe is thereby ignited and continues to burn at great heat. This flaming metal torch is then used to melt a hole in the casting, being simply pushed into it like a hot knife into butter. It was found that a 14-inch length of the small pipe was sufficient to make a one-inch hole three and one-half feet deep in a casting in this manner. The hole is continually kept free from molten metal by the pressure from the cylinder of oxygen. Heavy masses of concrete may be attacked in the same manner. —*Practical Eng.*, 68:1920.

Two Developments which seem to be increasing in favor and usefulness are the development of the centrifugal casting of metals, particularly of tube and ring forms, which seems to offer much promise both in economy of cost and increase of quality; and the increased use of chill molds in the production of castings which have to be duplicated a large number of times, and in particular the increased use of pressure die castings. Chill castings are now being produced in brass and bronze and pressure die castings of intricate form in lead, tin, zinc, and aluminum base alloys. Only the lack of a satisfactory mold material prevents the possibility of producing pressure die castings in brass and bronze which could thus be cast to size and require little or no machining.—*Brass World*, 19:12, ¼ p.

Metallurgy

Ford Will Make Steel in New Way.—Direct production of steel from iron ore in one continuous process has long been a dream of metallurgists. Something over two years ago a considerable stir was caused in European steel circles by the announcement that a French metallurgist, Basset, had developed such a process and that a company had been formed to work it on a large scale. Reductions in the cost of plant, fuel and labor were claimed, and the over all cost of production was said to be only 50 per cent that of the standard method. Critics of some competence held these claims exaggerated, however. The Basset system is not the only one of its kind, however, and the Ford Motor Co. will test at its River Rouge plant the Bourcoud process for the direct production of steel. This process involves four separate stages. As in the Basset process, powdered fuel is used, and the first stage consists of the gasification of this fuel. In the second stage the iron ore is reduced by the gases thus formed; the iron sponge produced is charged into an electric furnace and the slag removed in the third stage, while in the fourth the steel is further refined if necessary. The material thus never gets cold from the time the ore is first heated, hence there should be a saving in fuel. Waste heat, moreover, is expected to furnish all of the power required for working the process.—*Automotive Ind.*, 50:1.

The Superiority of American Duralumin.—An interesting commentary appears in an editorial in *Chem. and Metall. Eng.* The greater experience of Germany in the alloy field of metallurgy, and the German's reputation for painstaking accuracy and carefulness have probably been responsible for the prevailing idea that no aluminum alloys have yet been made quite equal to the German. The impression has been dispelled, however, by a recent incident from which we learn that the German product has been far outstripped by the American, particularly with respect to that most important single factor—uniformity. It appears that Commander Weyerbacher, builder of the navy dirigible "Shenandoah," has stated in a conversation and in an unofficial manner, that American duralumin is uniformly dependable, while that produced in Germany is sometimes excellent and sometimes "not so good."

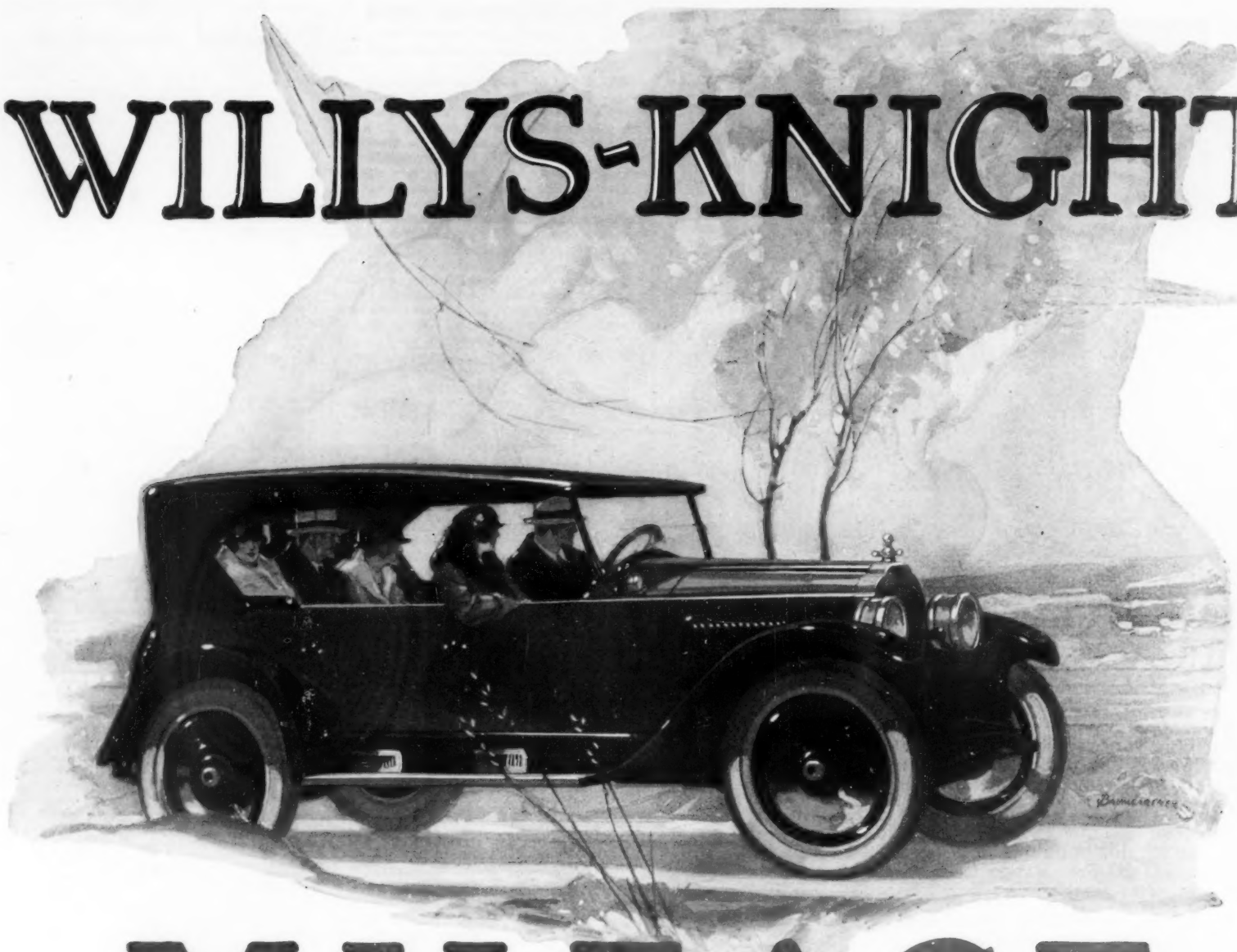
Tying Gray or White Cast Iron in Knots is now made possible by a new process invented by Alex. K. Schlaap. The process is very simple, consisting in heating the cast iron to a temperature shortly above the critical temperature of 1600 Fahrenheit, while protecting it in a muffle surrounded by a gas flame and open at the top. As soon as the gray cast iron reaches the proper temperature the muffle and its contents are removed from the furnace and allowed to cool in the open air. The whole operation requires about 45 minutes, starting from cold cast iron. The method has been in continuous use for a year, chiefly for the purpose of softening gray iron castings for machining purposes, and especially for making automobile piston rings. The most noteworthy characteristic, is the combination of pliability, ductility, malleability, and resiliency. In its resiliency the heat-treated metal most resembles steel, since it shows this property both before and after distortion. For example, a thin bar might be coiled up into a spiral and used as a spring, although, of course, not nearly as strong and resilient as a tempered steel spring. It is worthy of note that this annealed cast iron does not warp on standing. Samples of annealed iron have stood for several months without changing shape by as much as one thousandth of an inch, as compared with unannealed castings of the same metal and pattern, which have warped.—*Iron Age*, 113:1, 7 pp., ill.

The Effect of Titanium Additions in open-hearth steel treated with ferrosilicon as a deoxidizer is the subject of investigations made by the Bureau of Standards, described in Tech. Paper 241. It was found that a higher percentage of piped rails come from titanium- than from silicon-treated rails, but the time of teeming affects the number of pipes. The greatest number of pipes were in rails from steel treated with the smaller amount of ferrocarbon titanium per ton, and variations in the amount above this did not seem to affect the pipe. The titanium-treated rails were harder to break and showed more uniform fractures in the drop test than those treated with ferrosilicon. The titanium additions compared with the silicon additions had a marked effect in reducing the segregation of carbon at the top of the ingot. This improvement was approximately proportional to the titanium additions, but the effect falls off rapidly at the bottom ends of the A rails. Rail sections from the top of the ingots from titanium-treated heats were more uniform in hardness than those from similar positions in silicon-treated heats. This effect had entirely disappeared at the bottom of the ingot. The results of tensile, impact, and endurance tests did not show as much improvement from the titanium treatment as was expected from the decreased segregation.

The Practice of Analyzing Metals by Means of X-rays is only in its infancy. There is every reason to believe that soon great advances will be made in determining the crystallization and therefore the properties of metals. Students of metallurgy are well aware that the properties of metals and other bodies depend on the nature of their crystallization. The microscope has rendered valuable service largely because it enables the form and arrangement of the crystalline grains to be studied. The X-ray carries the same form of inquiry into a region 10,000 times more minute, thereby furnishing new evidence as to crystalline structures, so that it is now possible to see the atoms and the molecules, and the way they form crystals. Every crystal has its characteristic X-ray spectrum and can be identified thereby even when the individual crystals are beyond the resolving power of the microscope and the substance is in danger of being called amorphous. If a specimen contains a mixture of crystalline substances, the spectrum shows the combined effect of all the substances, and provided each individual spectrum is

(*Continued on page 198*)

WILLYS-KNIGHT



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This fine car keeps youth in your veins and age out of mileage. Its beauty keeps you proud. Its action keeps you happy. Mileage makes your heart grow fonder. As months follow months, you realize that Willys-Knight is the greatest investment in pleasure you could ever make.

The wonderful Willys-Knight sleeve-valve engine is utterly free from the woes and wear and tear of ordinary poppet-valve engines. It *actually improves with use!* Carbon literally makes it better — *increases* compression!

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5 Passenger Touring

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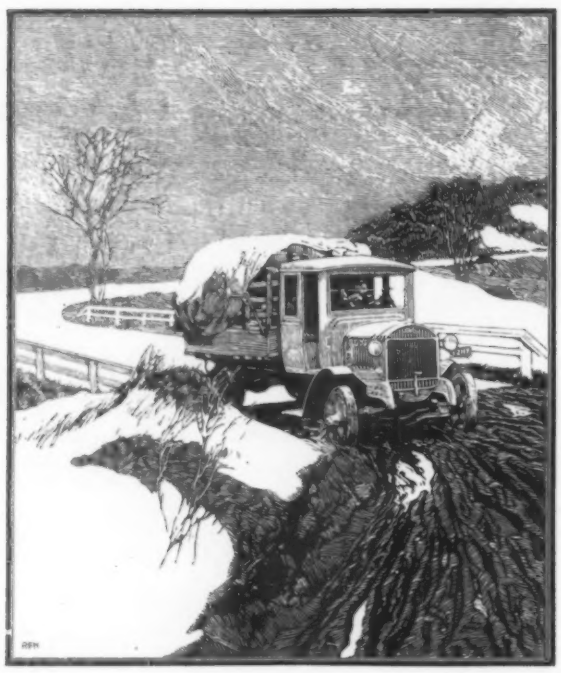

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For GMC trucks, if wheels can get a grip, will carry their full load anywhere—a fact made possible only by the surplus of pulling power provided by the now famous GMC Two-Range Transmission.

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GMC TRUCKS ARE SEVEN STEPS AHEAD

General Motors Trucks

GMC

Scientific American Digest

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known, the specimen can be analyzed.—*Iron Trade*, 73:26, ½ p.

Effect of Cold Work on Stainless Steel.—Most metals when distorted by cold work have a greater tendency to corrode than they have in the normal condition. Stainless steel is no exception to this and when severely distorted it rusts comparatively readily; for example, a coil of severely cold drawn wire will rust into a solid mass if left exposed to the atmosphere for a few months. The comparative resistance of the distorted and undistorted material can be shown, for example, by placing half of a broken tensile test piece of hardened and tempered stainless steel (which had been polished all over before breaking) in a solution of sodium chloride; corrosion will commence at the distorted end. As to whether corrosion will take place or not under stated conditions after a small amount of distortion, depends on the composition of the steel, and can only be settled by actual experiment, but the lessened resistance is always produced, just as it is by tempering a hardened sample. It is for this reason that a polished surface on stainless steel is more resistant than a roughly machined surface; the effect is due, however, not to the presence of polish on the former but to the absence of the distorted skin which is produced by the rough machining.—*Practical Eng., Note.*

The Calorizing Process consists in placing the material, such as tubes, in a rotary retort and heating in a reducing atmosphere of high temperature, the retort being filled with a mixture containing finely divided aluminum. The treatment infuses aluminum into the exposed portion of the metal to form a homogeneous aluminum alloy. This process is applied to materials already made. It is not a cast alloy but a surface treatment by which aluminum is actually driven into the metal (not merely deposited) and forms a new surface of aluminum alloy. The process is applied to steel or semi-steel products such as pipe, tubing, bars or other sections, thin sheets or small pieces. Calorizing renders material so processed resistant to heat, abrasion and certain corrosion, particularly air, water, electrolytic, alkaline and certain acid and other chemical actions. The structural strength of the material is maintained and the coating is an integral part of the metal protected. The electrolytic theory of corrosion explains the protective action of the aluminum coating of calorizing material. Examination of a sample of corroded modern steel will disclose deep pits or spots where the metal has been eaten through by rust. Analyses show that steel products of today, due to rapid production methods, contain impurities that localize and hasten corrosion by electrolysis. It is the familiar action of rusting in spots that is proving so troublesome in the application of modern iron and steel today. Aluminum is electro-positive to iron and because of the results secured by the process of impregnating aluminum into every void in the surface of the steel and alloying with the steel itself, densifying the surface and building it up to protect the base metal, corrosion of the base metal is definitely retarded by calorizing.—*Chem. and Metall. Eng.*, 29:27, 2 pp.

Titanium in Cast Iron.—The effect of titanium on the formation of graphite is somewhat like that of silicon, but more intense. This is true to such an extent that, independent of the content of silicon, the upper limiting percentage of graphite formation is exceeded when the titanium total reaches 0.1 per cent. Until the maximum amount of titanium has been reached the graphite-favoring influence of the titanium is greater than all other influences on mechanical properties. These properties are very greatly improved with increased content of titanium, but the percentage of graphite stays about the same. Increasing the titanium content renders cast iron less soluble in acids.—*Stahl und Eisen*, 43:49, 4 pp., ill.

A Study of Tarnishing carried out for the British Non-Ferrous Metals Research Association has brought out for the first time the marked difference in the mechanism of corrosion with different metals. This discovery promises to prove of the greatest importance, both from a practical point of view and as leading to a further elucidation of the whole question of corrosion. Three different types of tarnishing have been distinguished. In the first type, represented by copper, the tarnish film actually protects the metal from further attack, the progress of tarnishing becoming slower and slower as exposure proceeds. This is accounted for by

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the supposed continuous layer which the tarnish film forms, and the consequent difficulty the corroding constituents of the air find in reaching the underlying metal. In a second type the tarnish film is neutral, and the attack proceeds steadily, for instance, zinc in a dry atmosphere; in this case it is probable that the film is pervious to the air. Finally, the corrosion, while starting off fairly slowly, may become accelerated, and this forms the third type, exemplified by iron; it is suggested that here the corrosion product—rust—assists in the attack. Some metals, such as zinc, brass, etc., may follow more than one type of progress, according to the atmospheric conditions, or even to the thickness of the tarnish film. For instance, with brass the attack first proceeds uniformly, but later the film exhibits a protective influence and the attack slows off.—*Metal Ind.*, 24:1, 2 pp.

Mining

The Consumer's Power to Make or Break the Coal Market is made evident by an analysis of the relations between consumer's stocks and price, and it is found that this relation is almost mathematical. A reserve below 30,000,000 tons indicates a seller's market; 20,000,000 tons indicates a panicky market; and above 40,000,000 tons indicates a buyer's market in which salesmen again take the road and solicit business on the consumer's terms. On last September 1st, commercial consumers and retail coal dealers had on hand an estimated total of 56,000,000 tons of soft coal, which is equivalent to five weeks' output at the present rate of production. To equalize the seasonal demand for coal and relieve the winter burden of railway traffic would require the storage during the summer of only 20,000,000 tons more than is already stored. American consumers can manage to find storage for this additional 20,000,000 tons. It could be put away without involving the construction of new yards, simply by utilizing more effectively the existing storage facilities or by expanding the crude arrangement of the ordinary small plant.—*Coal Age*, 24:25, 3 pp., ill.

Chilian Nitrate Reserves are adequate for several generations, according to a writer in *Engineering and Mining Journal-Press* (117:2), who abstracts a long report on the subject which was submitted to Congress. It is stated that while it is very difficult to arrive at a full and accurate estimate of the amount of nitrate left for future use, the evidence that the reserves are adequate to the world's needs for many years, is overwhelming. Mining is exhausting the beds, but improved technology is rendering lower-grade material available. It seems fairly certain that long before the natural nitrate has been used up, satisfactory substitutes will be available in adequate quantity. Roughly the output doubles every decade.

Mine Samples and Delivered Samples of coal are not the same thing, according to *Technical Paper 344 of the Bureau of Mines.* Analyses of mine samples of coal are plentiful, but available analyses of delivered coal are relatively few. Mine samples are collected according to a standard method. The sampler cuts a channel 2 by 6 inches or 3 by 4 inches from roof to floor in the face of the seam and excludes from the sample any partings more than three-eighths of an inch thick and any lenses or concretions of "sulfur," or other impurities, more than two inches in maximum diameter and one-half of an inch thick. Analyses of mine samples form a permanent or scientific record of the coal bed at the point sampled. In the purchase of coal, mine samples may serve as a sufficient guide to the experienced purchaser who has knowledge of the impurities in the seam and the degree to which these are eliminated in mining and preparing the coal. To the average purchaser, unacquainted with these details, however, dependence on mine samples may be misleading. The quality of coal indicated by the face samples can rarely if ever be attained in the delivered coal. Certain impurities that are eliminated from the formally prepared mine sample may not be eliminated by the miner interested in getting out a large tonnage. Some of the roof and floor may also be included if these are soft or flaky. Some mine analyses, particularly those taken from geological reports, may be either from outcrop coal or small workings not beyond the influence of weathering. When coal prices are high and competition is lessened it is easy for the miner and the management to lower the standards of preparation of the coal, and a return to rigid standards is always difficult.

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Retardation of Spoiling of Butter.—A new method of butter manufacture is now being tried out in Holland and is meeting with considerable success. The main feature in this new process is that it delays the deterioration and the spoiling of butter. The new process consists in conducting the churning operation in an atmosphere of carbon dioxide. The air is sucked out of the churn and is replaced by carbon dioxide, which fills the pores of the butter and keeps out the oxygen as long as the butter is not vigorously agitated after exposure to the air. The natural process of deterioration is accelerated by the oxygen and any temperature above the point where the butter fats would congeal and close up the minute spaces where the oxygen could penetrate and produce reactions. The consumption of carbon dioxide in the new method of manufacture is said to be approximately one kilogram for every thousand kilograms of butter and its cost, together with that of the process, is considered negligible in view of the advantages gained. —*Jour. Ind. Eng. Chem.*

Cashew Nut Oil.—A series of experiments have been carried out recently with cashew nut oil in view of a suggestion that this oil could be used in pharmaceutical preparations in the same manner as almond oil. The results of these experiments are published in the journal, *Malaya Agricultural Journal.* The experiments showed that the kernels of the cashew nut were rich in oil, containing between 40 and 45 per cent. In extracting the oil from the kernel, it was found that due to the nature of the kernel it was necessary to exert a high pressure in order to get out of it the maximum yield of oil. The decortication of the nuts is a difficult problem in view of the leathery nature of the shell and the presence of a vesicant liquid. The cake which remains after the expression of the oil, is rich in albuminoids. In a sample obtained from the small laboratory hand press, it amounts to 23.4 per cent of albuminoids, corresponding to 33.4 per cent on the dry oil-free residue.

Changes in Powdered Rosin.—Some of the so-called constants of powdered rosin undergo pronounced changes within a short period of time, even when the rosin is stored in partially filled corked bottles. While the rate of change diminishes greatly after the first week, it continues at a significant rate for at least three weeks. At the end of six weeks the following changes took place: The acid number had decreased 5.3 to 9.3 points, the iodine number 47.3 to 52.2 points, the saponification number had increased 5.1 to 8.9 points and the melting point 8.9 to 11.3 degrees.—*Jour. Ind. Eng. Chem., June, 1923.*

Sirup From Sweet Potatoes.—A method for the commercial manufacture of sweet potato sirup, based on laboratory and plant experimental work, has been developed by the Bureau of Chemistry. From the standpoint of quality, this sirup has possibilities for use as a table sirup, for cooking purposes and in the manufacture of colored and short grain candies. For baking purposes it might find a use in dark products, such as ginger snaps. It also has properties which make it suitable for use in blending with other sirup to prevent crystallization. The commercial possibilities of sweet potato sirup are limited by the high cost of manufacture under the present method. For further details see United States Department of Agriculture, Bulletin No. 1158, July 3, 1923.

Solvents for Making Vanilla Bean Extract.—Because of the restrictions on the use of alcohol which have followed prohibition and the consequent substitution of other solvents for the extraction of flavors, some preliminary work has been done to determine whether or not these alcohol substitutes produce the same quantity and kind of extracts as those prepared with the aid of ethyl alcohol. The investigation was limited to several varieties of vanilla bean and tonka bean, and the solvents selected were isopropyl alcohol, ether, acetone and carbon tetrachloride to be compared with ethyl alcohol. The results show that the alcoholic solvents are much superior from the standpoint of quantity of extraction, the carbon tetrachloride being the poorest in this respect. It is possible, however, that a preliminary extraction with ether or carbon tetrachloride followed by a weak alcoholic solution may be found to be practical. For further details see *Journal of Industrial and Engineering Chemistry,* page 782, August, 1923.

Making Flexible Artificial Leather.—The flexibility of artificial leather depends to a large extent on the character of the backing on which the coatings of nitrocellulose or aceto-cellulose are built up. For this purpose is now proposed a closely woven cotton fabric with considerable pile. The fabric is dyed and passed through napping machines to give it a greater pile. A series of coatings is then formed on this background from mixtures containing nitrocellulose and castor oil. Then the material is embossed. This product will resist the action of heat, rain and snow and the wear from wind-blown sand.—*Export.*

Pilchard Oil.—A description of the various properties and constants of pilchard oil is given in the *Journal of the Society of Chemical Industry,* February 9, 1923, pages 47T to 48T. The pilchard is a fish, a member of the herring family, and the pilchard fishing industry is carried on almost entirely off the coast of Cornwall, England. The present method of obtaining the oil from the fish is somewhat crude, but the oil product is very clear and clean, being free from nitrogenous and other rank impurities. From one and one-half to two gallons of oil are obtained from one hundred kilograms of pickled pilchards. In 1921 there were produced 60,000 gallons of the oil, which was utilized mainly for the manufacture of soft soap. Inasmuch as the oil "gums" readily when exposed to the air, it is not suitable for lubricating purposes, and for a similar reason it is unsuitable for use as a substitute for linseed oil in the manufacture of paints and varnishes. The oil, however, yields a good soap which is quite transparent, of pale amber color and equal in quality to the usual fish-oil soaps.

New Use for Dyes.—In an interesting article in *Industrial and Engineering Chemistry,* August 26, 1923, P. A. Kober describes a reliable method for controlling temperatures in heating processes which consists in applying a liquid dye to the heated product, the disappearance of or change in color indicating that the part to which the color has been applied has received a definite amount of heat. Many dyes break down readily on heating, a large proportion of those found suitable belonging to the triphenylmethane series of dyestuffs. Among possible applications the method may be used in controlling the annealing of glass or the baking of cements or other mixtures, and to indicate the overheating of parts of electrical apparatus and instruments. A further development consists in using two dyes to indicate when the heat applied has passed a maximum as well as a minimum temperature limit. The following dyestuffs in certain proportions act as good double indicators: Chemco Blue and Chemco Red; C.P. 196 Malachite Green; Malachite Green and Rubine Red; Erythrosin and Neptune Blue.

Use of Ozone in Ventilation.—In the past few years the question of utilizing ozone for purifying air in ventilation of buildings and also the air of refrigerating plants has been receiving much attention. In the past the expense of production has been a great drawback to its extensive use. The electrolytic method has been considered standard for several years: Ozone being a rare gas with active oxidizing powers may be used for the purifying of air used in ventilating public buildings, for the removal of odors and for destroying bacteria. Its use has also been proposed for bleaching textiles and sterilizing them. The United States Department of the Interior through the Bureau of Mines is cooperating with the Society of Heating and Ventilating Engineers in four different problems which are of considerable importance. They are as follows: Methods for the quantitative deter-

(*Continued on page 202*)

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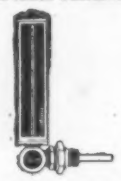
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Service of the Chemist

(*Continued from page 200*)

mination of ozone and oxides of nitrogen in ozonized air. Amounts of concentration that will produce the desired results and the limiting amounts that are permissible to breathe without producing harmful effects. Tests of ventilating systems in which ozonized air is used. The use of ozone in connection with recirculation of air in buildings.

Practical Use of a Rare Element.—For the first time in Great Britain an installation of neon lighting is now being applied outside the London Coliseum. The apparatus is one of the most interesting evolved since the introduction of electric lighting. Neon lighting is carried out by means of glass tubes from which the air has been exhausted and replaced by a small quantity of pure neon gas at a pressure very much below ordinary atmospheric pressure. This neon gas is rendered incandescent by the passage of a high voltage alternating current, passing between two metal electrodes fitted at the ends of the tube, the color of the incandescent gas being a peculiarly rich form of flame color. By means of a rotary converter the direct current supplied from the street mains is converted into alternating current that is required to operate the light.—*Chemical Age (London)*.

Bean "Boards" Something New.—Bean "boards" is a new article which one of the mills in Dairen, China, recently started to manufacture. It is used for feeding animals and is chiefly exported to America. The "boards" are of rectangular shape, measuring 28 by 12 inches, with a thickness of eight-tenths of an inch. By submitting them to higher pressure than is applied in the case of beancake, they contain less moisture, rendering them less liable to become moldy in transit. The venture is still in the experimental stage, and its future is looked forward to with interest.

No Saccharine for Belgium.—The importation, manufacture, transportation, holding and sale of saccharine and similar products, or the importation and manufacture of products containing these substances is prohibited in Belgium.

Paper Coffins. — Germans are being bothered even in death with financial problems. At Zwickau a cardboard box serves to line a brick casket, and in some other cities they use a coffin, the bottom of which slides back after it has been lowered into the grave, depositing the remains on the ground so that the coffin can be salvaged.

Radium From Russia.—Soviet Russia is to mine radium ore and produce radium. It will be kept at the Radium Institute of the Academy of Science which will maintain exact records of the production of radium and of supplies on hand without making requisition from the present holders.

Destructive Action of London Fog.—The Houses of Parliament are in danger of losing much of their artistic beauty by the action of London fog which crumbles the stone, thus eliminating the finer details. Frequently experts in examining inaccessible parts use powerful glasses, and if the part looks suspicious a scaffolding is erected to enable a thorough examination.

Labrador Gold.—The Geological Survey of Canada has issued a report which indicates considerable doubt as to whether placer gold is to be found in any considerable quantities in Labrador, which has been heralded as a new Klondike. The chances for the occurrence of rich placer deposits "seem very remote," and some of the advertisements relative to the reported goldfield "seem improbable," states the report. It is pointed out that Labrador was intensely glaciated and swept clean, the ice sheet being unhampered in its movement seaward and that there is little likelihood of placers having since been formed in Labrador.

Candy Does Not Supplant Alcohol.—The expected boom in the candy business by reason of the adoption of the prohibition amendment has failed to materialize, according to the President of the National Confectionery Salesman's Association of America which had its annual convention recently at Atlantic City. Apparently the only effect of prohibition on the candy trade was to bring into the business many inexperienced manufacturers who had anticipated an enormous increase in business. Strange to say approximately 60 per cent of the candy consumed in the United States is consumed by children in the form of "lollypops" or sticks.

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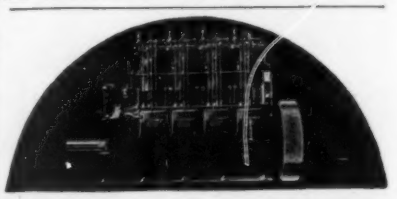

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Where the lead is

Without leaving his seat the modern car owner turns a switch, and electric lights flood the dark road before him. He turns another button, presses a pedal, and his powerful motor hums merrily beneath the hood in front of him.

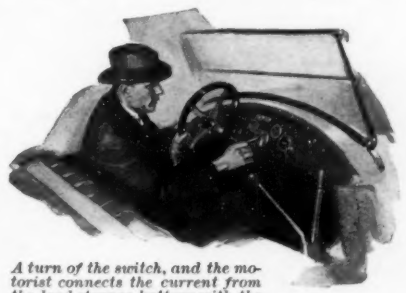
In making possible this picture, man has called upon the aid of lead. The storage battery that provides electric power for automobile lights, starter, and ignition is mostly lead. It consists of lead plates, every other one covered with litharge and the rest with red-lead. Both litharge and red-lead are obtained from metallic lead. The plates are in hard rubber containers that have lead in them.

This use of lead in connection with more than 13,000,000 automobiles and trucks in operation today gives you an idea of the amount of lead the automobile manufacturer puts into his product. While this use accounts for the most of the large tonnage of lead used in an automobile, it is not the only use of lead.

Putting lead to work

The next time you step into an automobile, remember that if it were not for lead-tin solder, the seams of the gasoline tank would leak. The same kind of solder seals the radiator that helps to keep your engine cool and holds in place the windings of wire in the generator that charges the lead storage battery.

Every time you turn a hard-rubber switch button on your instrument board you are touching something that contains lead. When you adjust the mass of wiring about your motor, fingers grasp its soft rubber insulation, which also has lead in it. The rubber tires,



A turn of the switch, and the motorist connects the current from the lead storage battery with the ignition and starting systems.

rubber top, and the rubber mat on the car step contain lead. The electric light bulbs are made of lead glass. Ground coats of hand-painted cars and light colored finishing coats are sometimes white-lead.

Besides the lead that the car manufacturer uses in giving you a completed automobile or truck, we must add the amount of this metal which helps to refine the gasoline that feeds the engine. Litharge helps to produce more than 4,500,000,000 gallons of gasoline for the yearly consumption of motorists in this country.

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OF even greater importance, so far as tonnage goes, than the use of lead by the automobile manufacturer is the lead that you use in general painting. In one year approximately 350,000,000 pounds of white-lead are used on surfaces such as wood. For protection against the ravages of rust nearly 20,000,000 pounds of red-lead are applied to metal surfaces annually.

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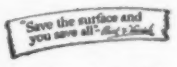

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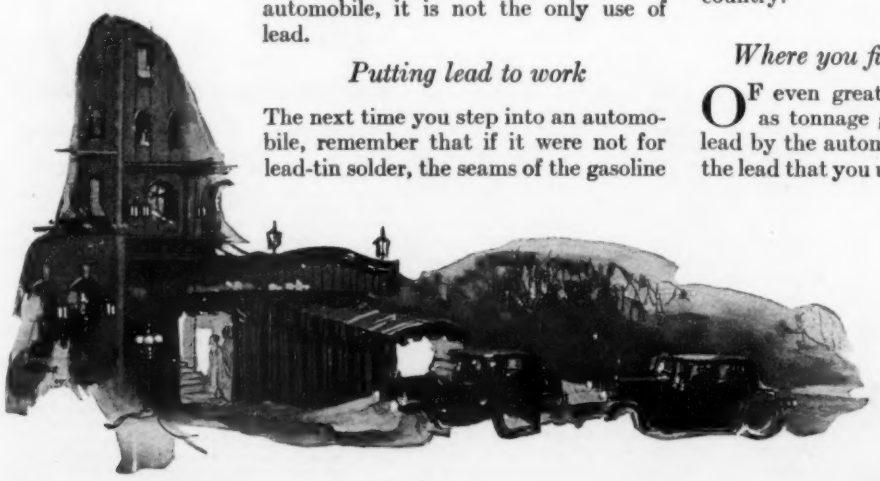

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New Prices on CUNNINGHAM TUBES Now in Effect

C-301A—5 Volts 1-4 Ampere filament $6.00
C-299—3 Volts, .06 amp. Dry Battery Det. and Amp. $6.00
C-300—5 Volts Gas Content Detector . $5.00
C-11—1 Volts .25 amp. Battery Det. and Amp. Special Base . . $5.00
C-12—Similar to C-11 with standard base $5.00

PATENT NOTICES Cunningham tubes are covered by patents dated 2-18-08 and others issued and pending. Licensed for amateur, experimental and entertainment use in radio communication. Any other use will be an infringement.

E. T. Cunningham Inc.

HOME OFFICE
182 Second Street SAN FRANCISCO — 154 W. Lake Street CHICAGO — 30 Church Street NEW YORK

The care and operation of each model of Receiving Tube is fully explained in our new 40-page "Radio Tube Data Book." Copies may be obtained by sending ten cents to our San Francisco office.

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and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete tube set having a range of 500 miles and more, including tube, head set, batteries, and antenna equipment, as low as $23.50.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets, all the most up-to-date devices—at the lowest possible prices.

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Radio Notes

Re-Broadcasting American Programs in England has become a rather commonplace feat. Recently the programs of the Westinghouse station, KDKA, have been intercepted by English stations and re-broadcasted for English homes. The KDKA station has been transmitting on a 100-meter wave length for re-broadcasting purposes, and this wave has been picked up by the Manchester station of the Metropolitan-Vickers Electrical Company and repeated on 385 meters.

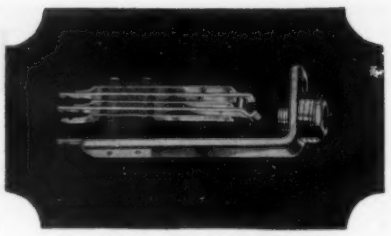
A Mercury Variable Condenser.—There has appeared on the market a variable condenser which makes use of liquid mercury under pressure. The application of greater or less pressure causes the mercury to spread more or less over the mica dielectric and to produce greater or less capacity effect. The mercury is entirely enclosed, eliminating all possibility of dust and dirt, and, therefore, leakage and noises. It is claimed that this new condenser will stand more than 5000 volts, so that it can be used for low-power transmission as well as for receiving. Because of the simple construction, the price is quite moderate.

Radio and the Farmer.—A special survey of about 1200 farmers just completed by the U. S. Department of Agriculture has disclosed the importance of radio in the production and marketing of agricultural products. More than 50 per cent of the 1200 farmers reported that they owned tube sets employing three or more tubes. A large number have home-made sets ranging from the simple crystal to the tube set. More than 75 different makes of sets were found among the manufactured sets purchased, although the bulk of the sets were confined to about 15 of the leading makes that are more or less widely advertised in radio and general magazines. The average cost of the manufactured sets was $172. Comparatively few of the owners of home-made sets operate crystal receivers, the survey revealed. The average cost of the crystal sets was $11. The average cost of the home-made tube sets was $83.

Is the Regenerative Set on the Wane?—That is a question which is being asked and asked often these days. With the recent progress in radio engineering it is fair to state that the regenerative circuit no longer occupies the important position which it did a year ago. Better circuits have been developed, which make for sharper tuning, less distortion, and positively no re-radiation. However, the regenerative circuit has done more to bring about radio broadcasting than any other factor. It was available at a time when there was nothing else that could even be compared with it in point of efficiency. It permitted the construction of simple sets which would bring in radio-phone signals from stations many hundred miles away. It made for loud signals, whereas, heretofore, single tubes produced barely audible signals. Nevertheless, and despite the many ingenious tuners which have been devised of late to give new life to the regenerative receiver, the fact remains that regenerative circuits are being superseded by radio frequency, neutrodyne, superdyne, radiodyne, super-heterodyne, and other circuits.

The Sealed Radio Sets of Australia.—A novel method has been adopted by the Australian Commonwealth radio authorities for protecting broadcasting stations. The regulations recently promulgated require that every prospective purchaser of a receiving set must present to the radio goods dealer a certificate of license showing that he has subscribed to the service of the station operating on the wave length to which the instrument being purchased is adjusted. If a radio enthusiast desires to listen in on additional programs he can have his receiving set so adjusted, but only on the production of certificates showing that he has made separate subscriptions to each. At a recent conference of Federal authorities, manufacturers, broadcasting companies, and dealers, the adoption of a uniform device for sealing receiving sets was decided upon. While the sealed-set regulations may be defeated by certain owners of receiving sets, the Government has authority to make surprise inspections of every set to see that the seals have not been tampered with. It is understood that the sealing device, which is added locally, will in no way interfere with the sale of American radio sets in Australia.

The Wave Trap is becoming more and more of a necessity in connection with sets which do not tune sharply and in localities where there are two or more transmitters at work on almost the same wave lengths.



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The Automatic Electrical Devices Co.
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A fine trade commanding a good salary and your services always in demand or you can start in business for yourself. At

BRADLEY INSTITUTE
The greatest school for watchmakers in the world. Address Horological Dept. H, Bradley Polytechnic Inst., Peoria, Ill., for our latest catalogue.

Burgess "A" Battery
Introduces a New Silent Partner

Notice that he's exactly my size—same height—same width—same weight. We look like twins.

He is VERTICAL "B" JUNIOR. He has the same 22½ volts of pep as the rest of the Burgess "B" family. He is quiet—never talks to himself and he never lays down on the job.

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Fortunately, the wave trap is a simple contraption and may be readily made or purchased complete at a low cost. The simplest kind of wave trap consists of a shellacked tube three inches in diameter, on which are wound ten turns of No. 18 double cotton-covered wire to serve as the antenna circuit. Around this winding is placed a layer of insulation, say oiled muslin, and a winding of 35 turns of No. 26 double-cotton-covered wire. This second winding is connected to the terminals of a 43-plate or .001 mfd. variable condenser. The first winding is connected to the antenna and ground, just the same as the receiving set. In fact, it is shunted across the terminals of the receiving set. Such a wave trap serves to "trap" undesired signals, which are tuned in for the closed oscillating circuit consisting of the second winding and variable condenser, there to lose themselves, so to speak, and not get into the receiver which is tuned for another wave length.

The Superdyne Receiver now steps up to the forepart of the radio stage and basks in the limelight. Like most of the recent advances in broadcast receivers, the principal feature of the superdyne is its special radio frequency amplifying circuit. Both the input and output circuits of the first tube are carefully tuned to the incoming wave, which is an arrangement that is bound to give remarkable results. The possibility of oscillations has been eliminated by the ingenious device of a reversed tickler coil. The tickler gives the tube negative regeneration, which discourages its tendency to oscillate instead of aiding it, as the usual tickler does. In tuning in on a station both the grid circuit and the plate circuit are tuned by variable condensers. If the set clicks and breaks into oscillation, it can be immediately stopped by a turn of the tickler or stabilizer dial. It may be necessary to turn the stabilizer at right angles to the grid circuit coil in order to pick up a station. As soon as the set starts to oscillate it should be tuned down immediately. Then, after both grid and plate circuits are tuned to resonance with the incoming signal the coupling between the stabilizer and the grid coil can be reduced until the volume of signal is as great as desired or until the set is just below the point of breaking into oscillation. Complicated as all this may sound, the set can be operated with but little practice. It will not only tune sharply, but it will bring in distant stations with ample volume.

The Loud-Speaker Horn.—The popular conception of the function of a horn on either a loud-speaker or a phonograph is erroneous. We hear that a horn "resonates" or it "concentrates the sound," or it "amplifies," and many other explanations, all of which are vague and most of them incorrect. It is true that a horn resonates at certain frequencies, and for that reason increases the amount of radiation at those frequencies. Any form of resonance, however, is undesirable because it is impossible to increase the amount of radiated energy uniformly at all frequencies within a wide range by this method. If a horn is not to distort, its walls should be non-vibrating and its air column resonances, within the range of frequencies used, should be slight. If we think of the term "amplification" as meaning the increasing of any form of response by supplying energy from another source, we see at once that a horn can not amplify because it can not supply energy, we learn from C. R. Hanna of the Westinghouse Research Laboratory. It should be evident, therefore, that a horn merely loads the diaphragm in such a way as to cause more sound energy to be radiated into the surrounding space from the diaphragm. The term "radiator" more accurately describes the action of a horn. A good horn, therefore, is one which causes the diaphragm to radiate almost uniformly at all frequencies within the desired limits. This condition is more easily attained in a phonograph than in a loud-speaker. In the phonograph the diaphragm is forced to follow the vibrations of the record except for the slight spring of the needle, while in the loud-speaker the diaphragm is not impelled to follow the variations of current in the windings because there is no rigid connection between the two. In the phonograph it is necessary only that the horn shall radiate uniformly at different frequencies for a given root mean square velocity of the diaphragm. In the loud-speaker the horn must fulfill this condition, and also help to cause the diaphragm to vibrate at a nearly uniform velocity when the same current at different frequencies is passed through the windings.

Eveready gives you the right battery *for every radio use!*

EACH Eveready Radio Battery represents thirty years of battery building experience. Each Eveready Battery represents millions of dollars invested in men, methods and machinery. Overseeing Eveready production is the greatest battery laboratory known to science, where every particle of raw material is required to pass Eveready's exacting tests. To insure Eveready serviceability, batches of Eveready Batteries are constantly being set aside for performance tests. And, finally, daily shipments keep dealers supplied with fresh Eveready Batteries, packed full of power.

To be certain of battery satisfaction, insist on Eveready Radio Batteries—they last longer.

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Radio Batteries
—they last longer

The radio dry cell triumphant

For economical, satisfactory radio, light the filaments of your dry cell tubes with the Eveready Dry Cell Radio "A" Battery. Will unfailingly outlast any other at ⅛ ampere current. Full instructions for getting this Economical Eighth, on labels and in our booklets. This battery will exceed your expectations in economy and performance.

Equal to all demands

Power flows from your "B" Battery, power that gives life to your head-phones or loud speaker. Some tubes draw more "B" Battery current than others, but whatever the tube or tubes you use, Eveready "B" Batteries will give you maximum results. Eveready "B" Batteries are made in six sizes, for all possible uses. Always use the biggest possible battery, for it contains more energy in proportion to cost, and lasts longer. Where space is limited, use No. 764, the vertical "B" Battery that occupies little table space but is packed with long-lasting power.

This battery is a wonder worker

Eveready's biggest contribution to economical and more satisfying radio is the Eveready "C" Battery, a triple-use, universal battery. It will make the loud speaker respond with a new fullness and naturalness of tone, and save much money by making the "B" Battery last still longer. Connect it with the grids of audio frequency amplifiers and notice the big difference. Can also be used as an "A" Battery for 199-type tubes in portable sets, and as a "B" Battery booster. Eveready Radio Battery No. 771—use it!

NATIONAL CARBON COMPANY, INC., New York and San Francisco
Headquarters for Radio Battery Information
CANADIAN NATIONAL CARBON CO., Limited. *Factory and Offices:* Toronto, Ontario

Informative and money-saving booklets on radio batteries sent free on request. If you have any radio battery problems, write to G. C. Furness, Manager, Radio Division, National Carbon Co., Inc., 216-218 Orton Street, Long Island City, N. Y.

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"What a whale of a difference just a few cents make!"
— all the difference
between just an ordinary cigarette and—FATIMA, the most skillful blend in cigarette history.

Electrical Notes

Geometry and the Photometer.—An icosahedron surface has been successfully used by the Westinghouse Lamp Co. for the measurement of the very largest street-lighting luminaires. Such a solid, having twenty faces, each an equilateral triangle, is more adapted to manufacturing than a sphere and occupies less vertical distance, without sacrificing any accuracy within the limits of commercial testing.

Cement for Porcelain and Glass Insulators is now available. It is sold as a dry powder, with the necessary quantity of liquid hardener for mixing. It is furnished in bulk quantities or in small lots, according to requirements. This cement is said to be a porcelain putty that sets and hardens at normal temperatures. No heat is used. For cementing, patching and repairing insulators of any size or type, the new cement forms a homogeneous mass with the material of which the insulator is made. In a few days it becomes as hard as flint, so the manufacturer claims. It is easily and quickly prepared. After being mixed to the proper consistency it remains soft and pliable for several hours. It requires no reinforcing and no heat to develop the full strength of the insulator.

The 110,000-Volt 4427-Foot Span over Carquinez Straits, on San Francisco Bay, is one of the interesting feats of high-power transmission in this country. The first crossing of the Carquinez Straits by a high-tension transmission line was one of the stepping stones in the progress of the electrical industry. The pioneers built well, and the march of events, with its demands for greater and greater blocks of power, found the crossing structure adequate for the new requirements. Constructed in 1901 for one 60,000-volt circuit, with a spare cable, two additional cables were added in 1914, making two 60,000-volt circuits. In 1922, coincident with the replacement of 60,000-volt pole lines by a 110,000-volt tower line, the crossing was modified to allow 110,000 volts on the two circuits, thus again practically doubling the transmission capacity.

The Underground Duct System of wiring is becoming increasingly popular in commercial buildings. For years architects and engineers have been confronted with the problem of installing sufficiently flexible systems of floor distribution for light, power and signal circuits to care for future requirements. Of late the problem has been aggravated by the tendency toward open offices, with the consequent uncertainty of desk locations, and by the need in industrial plants of changing motor locations or feeder circuits because of changes in production processes. According to *Electrical World*, the new system of wiring consists of a grid, loop or any other preferred arrangement of half-round fiber ducts connected at intersections by junction boxes which are merely laid in position (not actually attached to the components of the system) and the whole incorporated in the floor fill so that outlets can be placed at the beginning or after the floors are completed. Either single-duct or double-duct can be installed, depending on whether the electric power and signal circuits are grouped in the same duct or separated. Access to the duct is obtained through inserts or outlet fittings placed at the start or after the floor is finished.

Electricity Roasts Beef for 5000 People.—A new and unusual application of electric heating was made recently when electrically barbecued beef was served to five thousand people at the annual round up and celebration at Ephrata, Washington. We learn from *Electrical World* that four steers weighing about two thousand pounds each were dressed and prepared for the barbecue and roasted in a large electrically-heated pit built especially for the occasion. The improvised oven was 32 feet long, 4 feet wide and 6 feet deep. Twelve heating elements each of 3 kilowatt capacity and consisting of about 150 feet of No. 14 iron wire were placed one foot above the bottom of the pit. Sheet-iron heat deflectors were placed one foot above the heating elements, and a foot and a half above the deflectors were placed iron bars to hold the beef. Thermostatic control was provided to maintain an even heat in the pit. The meat was first roasted at a temperature of 550 degrees for two hours. The heat was then reduced to 350 degrees and maintained at this point for four hours. For the next six hours the temperature ranged from 250 degrees to 300 degrees. At midnight the meat had been roasting for twelve hours, and the temperature was then reduced to 200 degrees and held there for twelve hours until the time of the barbecue.

FREE!

Radio "Applause Cards"*

"——Station K-C-L-X signing off. If you have enjoyed the artists' program, won't you write in and tell them?"

By all means! Quickly and easily with "Applause Cards."* They're handsomely printed mailing cards. All ready for you to fill in with your comments, sign, and drop in the mail box.

Keep a pack of them near your receiving set.

You can use "Applause Cards"* liberally because they are FREE AT YOUR RADIO DEALER'S.

("Applause Cards"* were originated by this Company, makers of the popular Dictogrand Loud Speaker and the Aristocrat Dictograph Headset. The only "Applause Cards"* are Dictograph Copyrighted "Applause Cards."*)

A big FREE package of them awaits you at your dealer's. Or if he has not yet stocked, WRITE US, GIVING HIS NAME, and we'll ship you a generous supply of "Applause Cards"* free, prepaid, direct. Dept. J-3.

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We have a plan whereby our active workers can get a Ford without cost, in addition to their big cash earnings. Get the plan—quick!

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Jacks!

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—low jacks
—that help the game

Oh, what we know about jacks! If we were to romp through our records I should venture to say we have sold jacks enough to make the side of the Court House look like a radiator hood on a Flivver. Yes! We have built hundreds of thousands of jacks for the most critical telephone work for years. If you need jacks and want to be absolutely sure they will deliver, just put "Kellogg Jacks" down on your order list. You can't go wrong.

A thoroughly efficient, snug little job at $1.10 apiece for 4 conductor Jacks.

Use—Is The Test.

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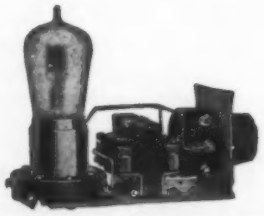


TYPE 300D AMPLIFIER UNIT

If distortion occurs in your audio frequency amplifier the results of your whole set are spoiled. Use only audio frequency amplifiers of proven quality. The General Radio Co. was the first company to offer commercially a closed core audio frequency amplifying transformer. It has been instrumental in the development and improvement of such transformers. Assure satisfaction in your set by using amplifying transformers and completely assembled amplifying units of proven quality.

Type 231A Amp. Trans.	$5.00
Type 300C Amp. Unit for UV199s .	$7.75
Type 300D " " " UV201As	$8.25

Send for Bulletin 916S

General Radio Co.
Massachusetts Ave. and Windsor St.
Cambridge 39, Mass.

A Wild Night on the "Shenandoah"

(*Continued from page 158*)

pulled forward the vertical rudder post, a heavy member measuring ten inches by ten inches, so that the top of this post is now about twelve inches from the vertical. It is needless to say that the covering fabric was in large part torn away from the wrecked frame; and it will be understood that the steering of the ship, complicated as it was by the gaping hole in the bow, became a very difficult matter.

To any one unfamiliar with the problem of airships and their structure, it would seem that the remedy for these troubles would be the simple one of strengthening the bow and stern construction; but to do this means to add additional weight to the ship and reduce the useful lift to that extent. But the useful lift, that is to say the difference between the dead weight of the ship and the lifting power of the gas, is the capital with which the airship designer has to work; and every reduction in the lift means a corresponding reduction in engine power and speed, or in the amount of fuel that can be carried and, therefore, in the radius of action of the ship. It is this demand for light weight with its consequent frailty of structure, which renders the designing of a dirigible such a ticklish job. Both German and English designers have stated that the "Shenandoah" is probably the strongest airship that has as yet been built; yet we see what happens to her in a winter's gale of a few hours' duration.

The escape from these conflicting conditions lies in the direction of greater size. Speaking approximately, the weight of an airship increases as the square of her dimensions, whereas the lifting capacity increases as the cube. Hence, it follows that an airship 1000 feet long can be built relatively of much greater strength and rigidity than one 650 feet long. Because of the greater relative buoyancy at his disposal, the designer can design such parts as experience has shown to be vulnerable with a sufficient margin of strength to stand up to their work. As a matter of fact, the ships which are to be built with the assistance of the British Government for the service between Great Britain, India and Australia, and those which will be built by the American Company which has bought up the German patent rights, will be of such dimensions as to make even the "Shenandoah" modest by comparison.

Our Abrams Investigation—VI

(*Continued from page 159*)

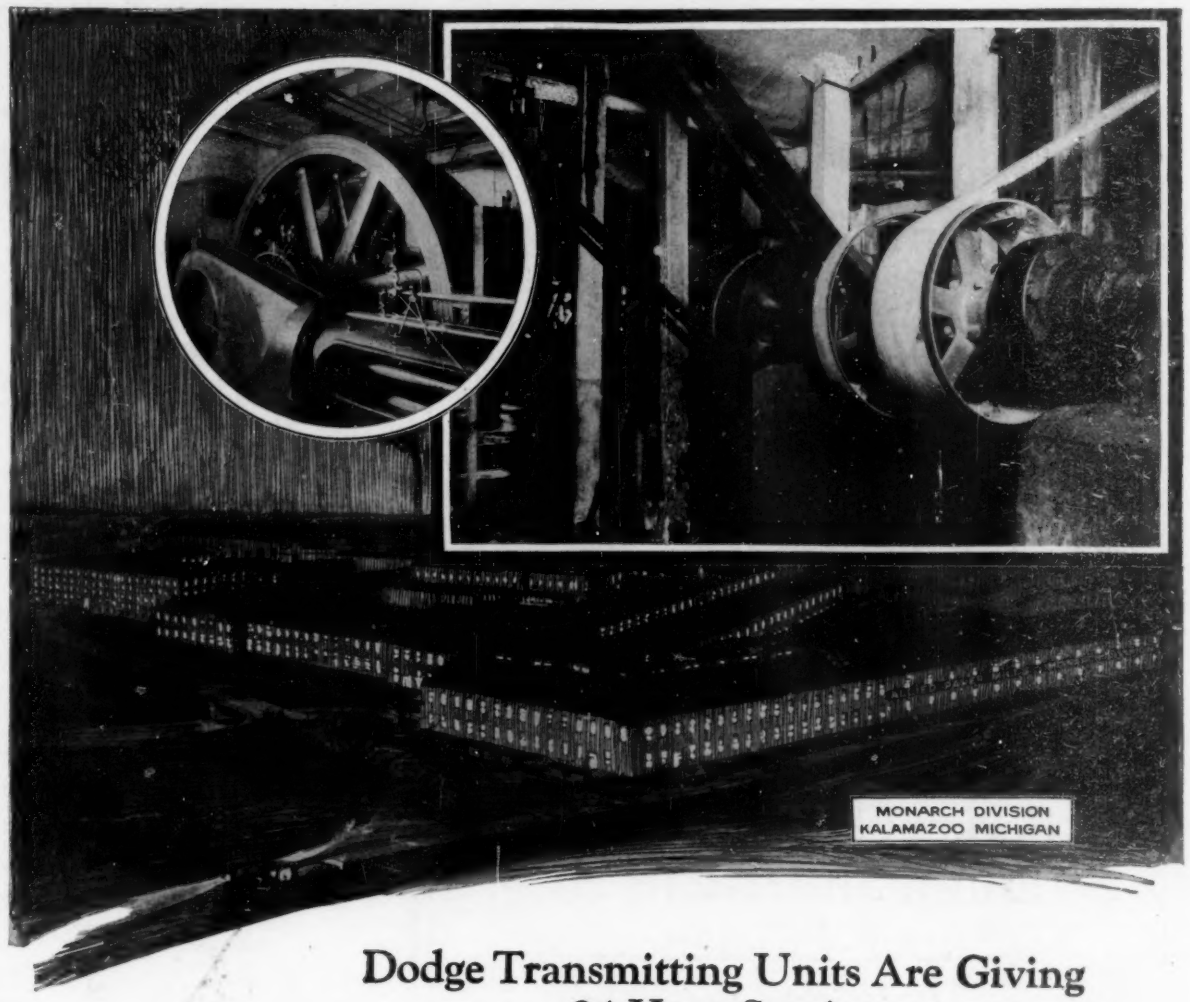
usable plane.

Dr. Abrams knew nothing or next to nothing regarding electricity, even though he made use of electrical apparatus in his work. Of course, he would tell you that he was applying electronic energy to his diagnostic and treatment technique, but even then he was on dangerous ground. No less an authority than Professor Millikan, probably America's greatest physicist in the field of the electron, investigated the Abrams apparatus and stated that it did not rest on any sort of scientific foundation whatsoever. Professor Millikan holds that the E. R. A. claims are the height of absurdity. If it is true that the electrons inside of atoms give off, under suitable stimulation, frequencies of definite period which are properly called electronic frequencies, then these frequencies are billions of times higher than any which the E. R. A. are using in their treatment, so that the use of the word "electronic" in connection with the Abrams method is misleading and unscientific. If there is anything in the E. R. A. technique, it is certainly not electronic, electrical or magnetic.

Not only did Abrams know little or nothing about physics; in the face of this he insisted on tying up physics with his theories at every possible turn, when there was no possible tie-up. His writings may have been convincing to some medical men interested primarily in the medical aspects of the case; but to the orderly and trained scientific mind, they were nothing short of bewildering. His book "New Concepts in Diagnosis and Treatment" was typical of his weird and rambling writings of late. In that work he failed to set forth his discoveries or describe his apparatus so that one could build the instruments and repeat his experiments. Early in our investigation we obtained a copy of this work, and try as we would to understand its seemingly significant contents, we had to give it up as impossible. It proved to be an incoherent hodge-podge. One might rise to say that perhaps our

(*Continued on page 210*)

IN THE ALLIED PAPER MILLS, KALAMAZOO



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"Dependable power transmitting machinery is as necessary to the manufacture of paper as is dependable paper to the production of fine printed works. Power costs always have been an item for the careful consideration of the mill executives, and in this period of high material and labor costs and the necessity for maximum production, we must watch every leak, be it power or material. We develop around 9,000 horse power, operate 24 hours six days a week, and trouble in our engine rooms or on our power line would stand us heavy losses."

In the Monarch Division of the Allied Paper Mills at Kalamazoo, Michigan, Dodge pulleys, hangers, bearings and clutches, and rope drive have been rendering 24 hour service, six days a week for 14 years.

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Five hundred local dealers distribute Dodge products on the immediate delivery basis. Trained engineers are always available for expert counsel on the special machinery demands of industry.

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The Executive's Interest in Power Transmission

He Should Realize Its Importance in Production

The executive is primarily interested in results as reflected on the balance sheet. He may not be particularly interested in a machine as simply a unit in the production of the plant; he may not care whether the machine employs rawhide or cast steel gears and pinions, but he is interested in the relation of that particular unit to his production costs and profits. Therefore, if the efficiency of one type of gear is higher than another type to the extent that it substantially affects production, it is believed only logical that he can be interested in gearing.

By the same line of reasoning it is believed equally true that the executive, being vitally interested in power costs as an important item of production expense, would be and is interested in the relative efficiency of the various means employed for the transmission of power from the boiler room to the machinery of production. He is interested because the percentage of power actually delivered to the machine producing the product varies greatly, according to the efficiency of the means used for transmission, and because the waste occasioned by inefficient systems of transmission, or the savings effected by efficient units have a definite and important bearing on the monthly financial statement.

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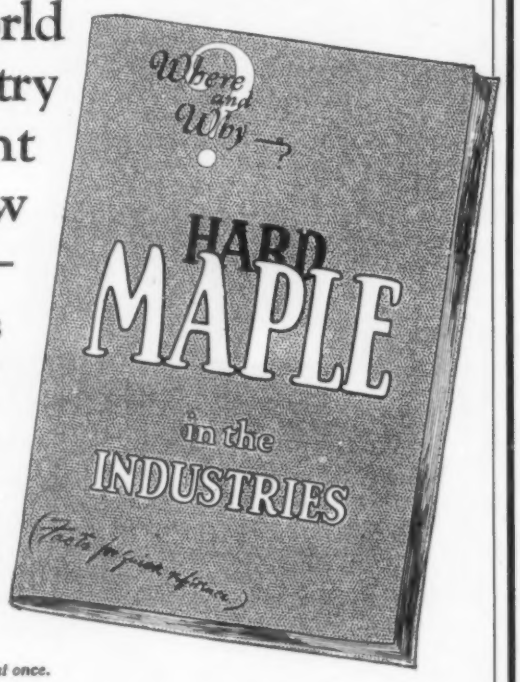

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Science Notes

A Digest of Everything of General Interest Appearing in Current Literature

New Telescope for Russia.—German papers report the delivery by an English concern of a huge telescope ordered by the Russian Government for the Nikolai Observatory on the Black Sea.

Study Climatology and the Weather at Home. — Clark University now offers a course in home study of "Climatology and the Climates of the World" as a companion to that on "The Passing Weather."

"Why the Weather?" — This is the name of a service furnished newspapers by a syndicate supplying scientific news to newspapers. Nearly everyone is interested in the weather and the newspapers can give up a certain amount of space to this subject with advantage to the public.

The Nightingale's Song in England.— A party of 60 recently stayed up all night in the Surrey woods to hear nightingales sing, and they were well rewarded for their sacrifice of sleep and comfort. Nineteen songsters were distinguished. The spot selected was an old quarry.

Meteorological Degrees. — This year two degrees were given in Meteorology by George Washington University. The only other degrees of Doctor of Philosophy for Meteorology were given by Johns Hopkins University in 1899. Harvard in 1914 and 1917 and at Wisconsin in 1918.

Longer Sheep's Wool. — Dr. Serge Voronoff has announced a new discovery which may prove of great value to wool growers. He states that the transplanting of glands from one sheep to another will cause the wool to grow 10 inches longer than normal on the animal with the extra glands.

Foreign Fauna Study. — A traveling scholarship for the study of the fauna of foreign countries was announced by the Smithsonian Institution, which will devote the interest from a bequest of $50,000 to the project. The fund was given to the institution by the late Mrs. Virginia Purdy Bacon of New York. Those awarded the scholarship which will rotate every two years, will receive about $2,500 a year.

Presence of Mind.—A burglar in Wales, in a place which we cannot pronounce, was undone by finger prints secured under peculiar circumstances. A maid servant was awakened in true movie style by the burglar's flashlight. She said she felt faint and asked for a glass of water which he gave her and finding no valuables took his departure. He was traced by the finger prints on the glass and proved to be a pitman and an old offender.

The Hippopotamus and the Tennis Ball. — "Zeekoe" in life was a $5,000 hippopotamus in the Cincinnati "Zoo." Some ill-balanced or thoughtless person threw a tennis ball into the cage and hippopotamus-like "Zeekoe" swallowed it. The tennis ball was found wedged in the huge beast's stomach, where, unable to pass further through the narrow opening, it formed an obstruction, which resulted in the animal's death after four days of suffering. "Zeekoe" got by after swallowing a lady's mesh bag, but the tennis ball was too much.

Burroughs' Memorial. — Henry Ford has given John Burroughs' place in the town of Esopus, N. Y., to the John Burroughs Memorial Association. In his will Mr. Burroughs left "Slabsides" and the house at Roxbury, known as "Woodchuck Lodge," to Dr. Clara Barrus and gave her exclusive control of both places as long as she should live. The Memorial Association which had intended to acquire both properties, was unable to raise the required money, but Mr. Ford came to the rescue by obtaining the interest of Dr. Barrus in "Slabsides," which he has turned over to the association.

Fails to Find Insulin.—Experiments conducted by the Fisheries Bureau in an effort to extract insulin, used in treating diabetes, from the alimentary canals of sharks were said by bureau officials to have been "not very successful." Working with the Public Health Service the bureau obtained about 16 pounds of pancreas tissues from various species of sharks but a laboratory test failed to develop any insulin. The present source of supply is the pancreas of cattle. The failure of the experiment, however, may have resulted from the length of time which elapsed after the sharks were killed and before the laboratory tests were possible.

Professor Pickering Resigns. — Prof. William Henry Pickering is to resign in September, 1924, and will become Assistant Professor Emeritus. He was born in Boston in 1858 and graduated at the Massachusetts Institute of Technology in 1879. Professor Pickering is the discoverer of the ninth and tenth satellites of Saturn and has made many contributions to astronomical knowledge. Professor Pickering in 1900 established the astronomical station for the Harvard Observatory in Mandeville, Jamaica, where he now lives. In 1891 he established the Arequipa, Peru, station of the Harvard Observatory and erected an observatory and telescope for Dr. Lowell at Flagstaff, Ariz., in 1894.

Elephants Increasing.—The elephant is a very useful animal both for draft purposes and for ivory. A few years ago 70,000 were slaughtered annually for their tusks so that it seemed as though there was a good chance of the big animal's becoming extinct. Wise laws, however, have checked the destruction so that the number is increasing. The war gave the elephants their chance and the British authorities in East Africa have also protected them. South of Zambesi the elephant is virtually extinct and the Cape market for ivory has ceased to exist. At present Mozambique is the center of the ivory trade. Oddly enough the Portuguese, through whose hands it comes, send nearly all the ivory across to Bombay, where it is sorted and cut and dispatched to the European markets. The world's supply of real elephant ivory is now about 250 tons a year.

Tryparsamide for Sleeping Sickness.— Sleeping sickness of Africa is not the same as that known in this country. It is caused usually by the bite of the tsetse fly, which spreads the trypanosomes, as the irritant germs that cause the disease are called. The problem was to find some drug which would kill these trypanosomes in the blood in all parts of the body, and which would, at the same time, not harm the body, an exceedingly difficult and delicate matter. Dr. Walter Jacobs and Dr. Michael Heidelberger of the Rockefeller Institute undertook this task. They took arsenic compounds and experimented with them, failing time and again to gain the desired effect, but noting the results carefully and altering the compound 63 times, they finally succeeded. That is why the drug tryparsamide, used with such success against the sleeping sickness and paresis, is known as A63, the sixty-third arsenic compound. The first experiments were conducted on animals, and when tryparsamide had proved its value, Dr. Louise Pearce went to Africa and experimented with it on the natives.

Hawaii National Park.—The Department of the Interior has just issued for free distribution a 16-page illustrated booklet on Hawaii National Park, which is described as a playground of easily accessible marvels available 365 days in the year. The booklet describes the various park trips from the city of Honolulu. The park is comprised of three separate areas, two of which are on the island of Hawaii, the third being on the island of Maui; this latter, the Haleakala section, contains the largest extinct volcano in the world within the crater of which it is said could be placed the city of Philadelphia. The Kilauea section contains the famous "Lake of Everlasting Fire," which is so convenient of approach that automobiles are driven to the brink of the pit. The Mauna Loa section includes the huge crater of Mokuaweoweo at the summit of Mauna Loa, altitude 13,675 feet. The Mauna Loa trip is described as a three-day riding or hiking excursion from the Kilauea Volcano and it is said the lava formations provide a variation of interests that more than rewards one for the rather strenuous climb. Copies of the Hawaii Park booklet may be obtained by addressing the National Park Service of the Department of the Interior, Washington, D. C.

Thomas A. Edison in his laboratory. Taken from an old print.

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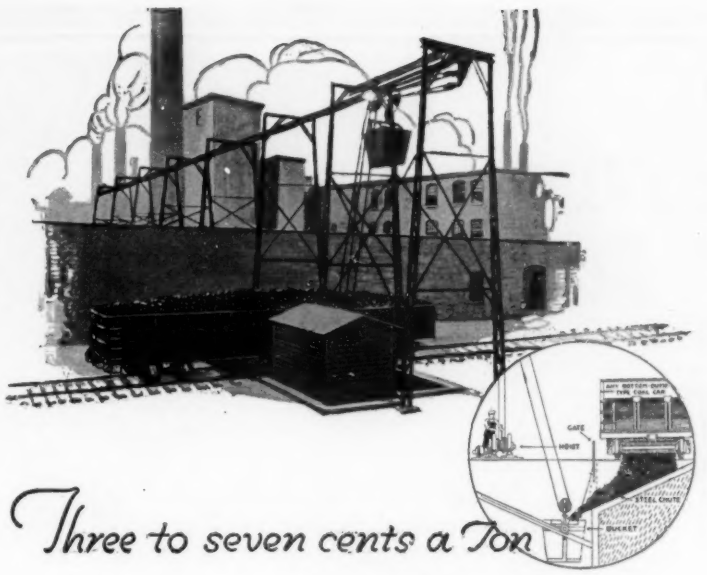

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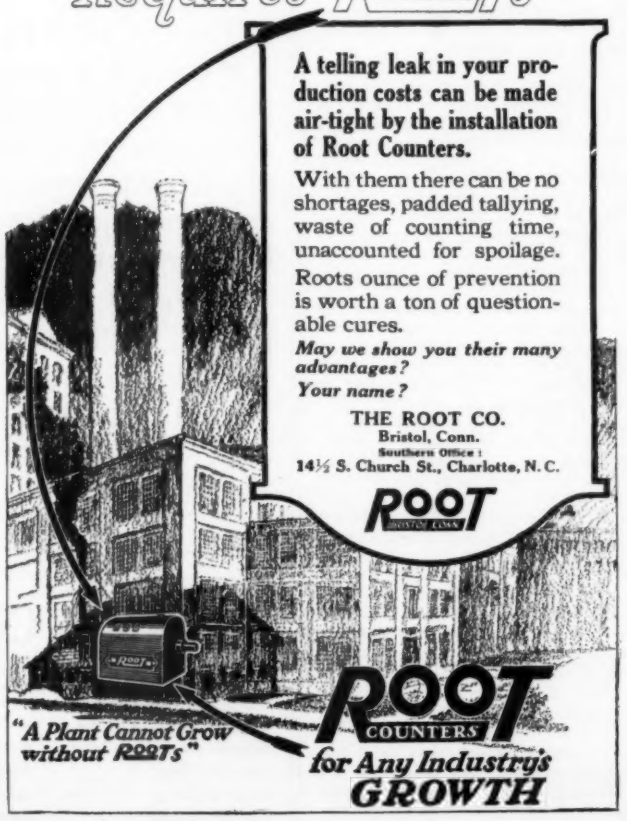

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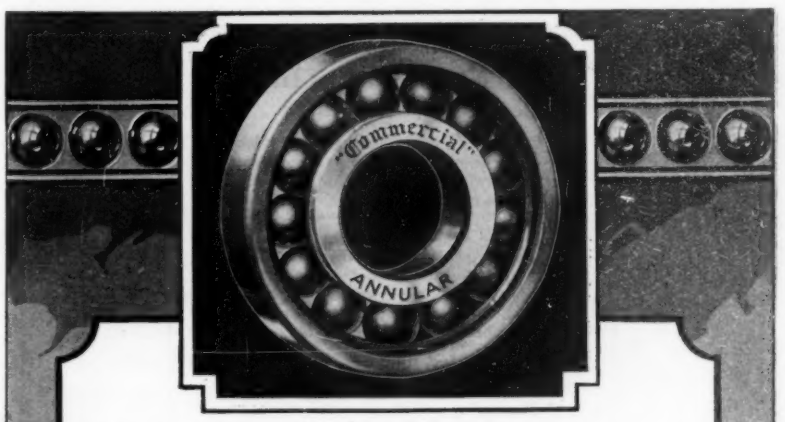

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Our Abrams Investigation—VI

(*Continued from page 207*)

mentality was of insufficient capacity to grasp this great truth. To which we reply with becoming modesty that we have mastered the Einstein theories, the various works dealing with the intricacies of electronic structure of matter, and, what is especially pertinent, that our everyday work brings us in touch with all manner of new ideas which we must examine, understand, appraise, and pass upon.

It may not mean much to the average medical man that Dr. Abrams, from our study of the man, knew virtually nothing about electricity. We doubt if he could have hooked up a door bell and made it work. He had no conception, apparently, of the need of a closed circuit. Look, for instance, on page 272 of his work, "New Concepts, etc.," and you will see the wire carrying the "energy" running to one pole of a step-up transformer—a one-inch spark coil, in this case. He apparently did not know the difference between the primary and the secondary windings, so in the text he simply states that it goes to "one binding post." The picture indicates that it goes to one pole of the primary. A wire runs from one pole of the secondary to the ground, while another from the secondary goes to the human detector. As he had no particular use for the other pole of the primary, he left it vacant! Note on page 43 his difficulties in telling the N from the S pole of a magnet. On page 143 he says "the vibratory rate for tuberculosis is 15 ohms." Today it seems to be 42 ohms. On page 187 we find this wonderful statement, "The voltage of the latter is usually very high and varies from 2 to 17 ohms." Further, on page 209, you will note this gem, "An ordinary dry cell of 1½ volts and 12 amperes discharges, from the negative pole, an energy value of 70 ohms (with biodynamometer). This energy discharge occurs during the flow of the current irrespective of the distance of the poles on the body of the subject." On page 234 is another riddle: "The energy discharge from a giant magnet with a lifting power of approximately 400 pounds to the square inch has an energy discharge of only 32 ohms." (The English is Abrams', as well as the physics.)

What is it all about? This sort of thing may have impressed certain medical men to give up their orthodox and less spectacular methods in favor of E. R. A., but to any one with even an elementary knowledge of electricity and physics, it simply does not make sense. Was Dr. Abrams totally ignorant of physics and electricity? Or did he intentionally write in this manner so as to surround his basic discoveries with impenetrable barriers of confusing and weird statements? Or again, was he really sane when he wrote these things?

And then the nomenclature of the thing. Dr. Abrams was never at a loss for new names for the simplest kinds of things. A resistance box became a "reflexophone"; a magnet became a "depolarizer"; a slide-wire rheostat with two electrodes became a "biodynamometer"; electrodes became "distal" and "proximal" electrodes; simple marks made by a tiny plumb bob moving over a smoked glass slide, as the consequence of involuntary muscular action of the reagent's hand, became "gyrograms" or "pathograms"; a combination of spark coils, tuning coils, variable condenser, electrodes and connecting wires became a "sphygmobiometer," and so on. Little wonder that few of the E. R. A. men remember the names given to these various instruments and to the various phases of E. R. A.

Not alone in his writings, but in his experiments there is the same sort of weird, meaningless, and even ridiculous atmosphere. He was forever working on something new. He went from one idea to another, with little loss of precious time. He would get together an assortment of radio instruments, projection apparatus, frog legs, measuring instruments and so on, and announce to E. R. A. circles that he was on the verge of measuring the disease energies and dispensing with the human reagent. In recent months he had several young electrical men working on these ideas, some of whom soon left his employ after determining for themselves the small opportunities available for serious scientific development work. We have been in touch with several of these men and have their stories. He made full use of the supersensitive characteristics of radio oscillating circuits and loud-speakers, presenting the normal phenomena of these circuits, well known and understood by all

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electrical engineers, as amazing new manifestations of the electronic forces.

Dr. Abrams may have been the greatest benefactor of mankind, as he has been represented by enthusiastic scribes and his ardent followers. He may have been that in thought and in spirit, but not by the usual signs. Instead of presenting his discoveries to the world in the way of all the great medical pathfinders, he preferred to keep them a dark secret. His apparatus has been kept sealed, so as not to disclose the working members, and has been leased to practitioners at rentals so high that they could ill afford to use the E. R. A. method except for extravagant fees from their patients. The rebuttal to all this is that Dr. Abrams desired to build up his technique in a lasting way, and to that end he insisted that a fair share of the vast sums of money received for electronic treatment should go towards the building of an electronic college and laboratory in San Francisco, the foundation of which has already been laid. Concerning the electronic college, more might be said at this time, but space forbids. Suffice it to say that Dr. Abrams did not follow the ethics of the medical profession in the matter of *giving* his great discovery to the world. His estate is variously estimated to be between $2,000,000 and $5,000,000. No doubt, he was a true benefactor to many doctors who, before taking up E. R. A. technique, were handling a rather mediocre practice, but who, later, became quite well-to-do in very short order. This fact is by no means denied; if anything, Abrams was quite proud of his helping hand to thousands of practitioners, raised from penury to affluence, as the saying goes.

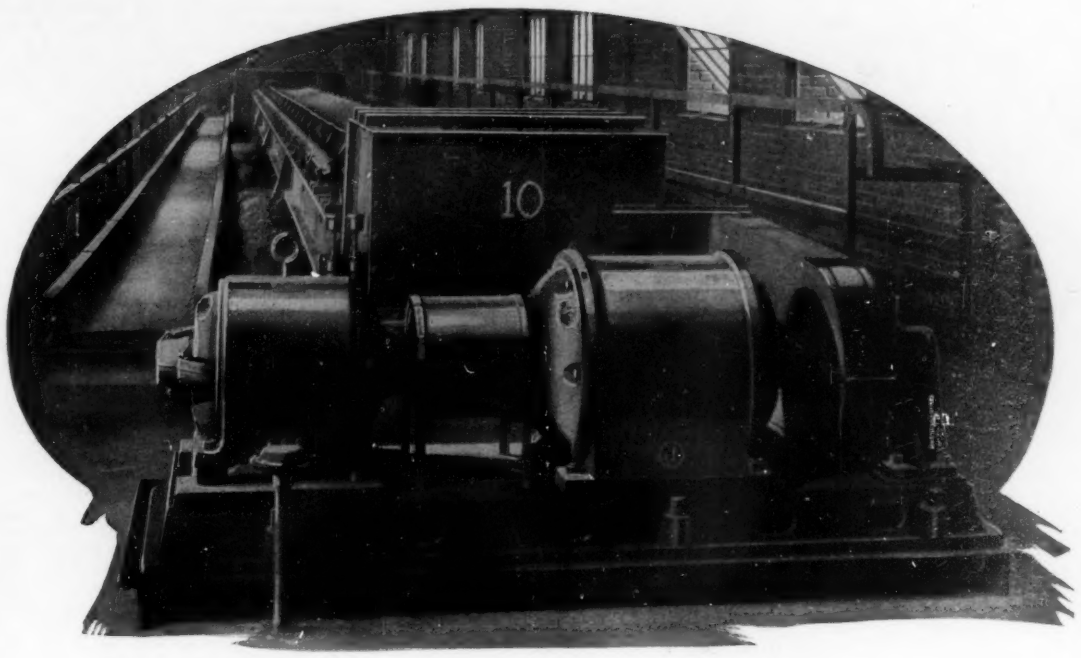
How did Abrams teach his method? So far as we have been able to learn, little of tangible value was being taught the students in their short and expensive course; and Abrams himself admitted that only half of them learned to make the diagnosis. Many students have admitted that they had little chance to learn anything. Abrams demonstrated his methods and made numerous diagnoses before his classes, and it was for the individual students to grasp whatever they could. Occasionally, they were asked to help in the procedure. At the completion of the course the students would sign up for the Abrams apparatus and depart for home, there to work the thing out for themselves. Some of them did make it work; others did not. We know both kinds.

Abrams was quite autocratic at all times. He was the leader. His word was final. No one might question his method or his findings. His students had to agree with all he said. If he announced a reaction, they had to experience it with him; there could be no alternative. It was decidedly Abrams' "show" from start to finish. Many interesting things were done, to be sure; but the students had no hand in the working conditions and there must have been little of evidential value in the demonstrations. Yet—many of them were "sold." As many of them have expressed it: "There must be something in it, somewhere!"

If we may be pardoned for doing so, we must record the violent temper of Dr. Abrams. He would demonstrate his methods just so long as conditions were of his own choosing. However, as soon as someone endeavored to impose checks or some kind of control so that the findings would have evidential value, Dr. Abrams would express his violent disapproval and, in many instances, he would leave the room in a towering rage. We were informed of this state of affairs, not only through past instances but by persons quite close to Abrams. Expressions of sympathy and serious apprehension were tendered to us, looking forward to the day, if it ever came, when we should meet Abrams face to face.

When our investigation of the Electronic Reactions of Abrams was first announced, we received a letter from Dr. Abrams stating: "I note that you contemplate investigating the ERA. I shall gladly place at the disposal of your investigators, with that object in view, my personal services and all the resources of my laboratory in San Francisco."

It seemed as though our work would be materially simplified. We also began to incline to the idea that Dr. Abrams must have something basically true and provable, and that he had been grossly misrepresented by previous investigators. Soon we began to suggest preliminary tests, which could be conducted by mail or express; we proposed sending out pure germ cultures, which were to be identified by his electronic diagnosis. This, we were informed, could not be done. The test was not fair. Then we proposed



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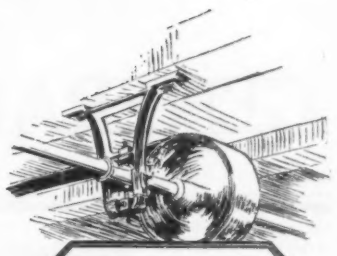

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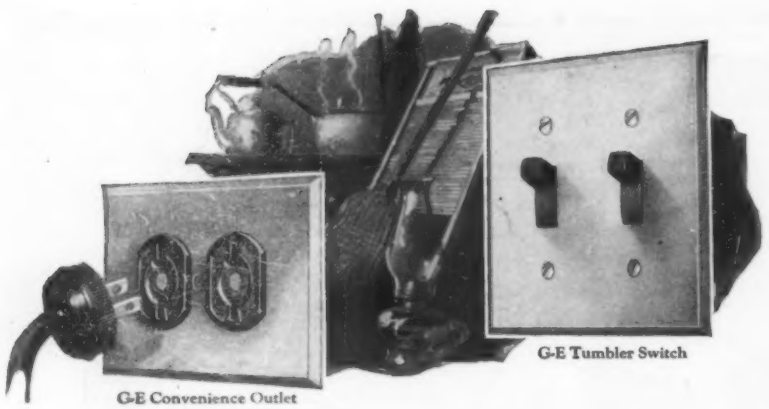

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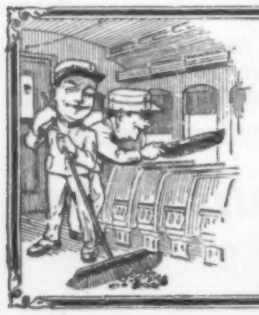

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sending blood specimens, prepared in whatever manner he might specify and with the cooperation of his duly appointed representative here in New York, so as to have the conditions fair and square. Dr. Abrams again declined, and wrote a long letter indicating in his customary involved and mysterious style why such a test could not be carried out. The main purport of his refusal was to the effect that since his 75 to 90 per cent accurate findings could not be compared with clinical findings, the latter being so utterly wrong as to be of no value, how could we judge the results? We were in the midst of formulating still other test conditions, such as submitting one set of blood specimens, getting his readings, and then taking the same set, changing the identification numbers, and re-submitting them for a check-up on his own original findings, when we learned of his unfortunate death. However, from what we had experienced and what we have seen and heard in the past, we sincerely doubt that Dr. Albert Abrams would ever have made a test for us.

His last letter to us, dated January 7th, dealt with several matters. It indicated a worried state of mind as the result of the Arkansas trial and the impending State action in Ohio. It pleaded for time as regard tests, inasmuch as a committee was being organized by one of the electronic organizations for the purpose of cooperating with us, and inasmuch as Dr. Abrams would have to consult that committee. It again brought up the report of our test with Dr. X, as reported in our November issue, and deplored the effect of that report on E. R. A. activities. It again brought up the essential difference between E. R. A. findings and clinical findings, and the impossibility of reconciling both these methods for passing on results. Six days before his death, Dr. Abrams wrote:

"You must remember that I have tried to point out to you on numerous occasions, that a test of this method cannot be compared with clinical findings; and a committee of men before they can appreciate a test, must qualify themselves as to the basic principles of my method so that they . . . themselves can sit down and repeat that same test with similar findings." Apparently if we don't get these, the test doesn't count! Apparently if we don't get them once, we may get them if we try again!

Five months of close observation of E. R. A. diagnosticians at work, and study of the entire technique lead us to believe that the matter is by no means a bare-faced fraud. Many of those engaged in the work—Dr. Abrams for one—are apparently sincere. They believe in the method. When they get proper results they are elated; when they get unsatisfactory or even ridiculous readings, they are bewildered and search for some far-fetched explanation of a pseudo-scientific nature.

The whole thing bears striking resemblance to the subjective psychic phenomena. Compare it with the Ouija, which spells out messages through subconscious muscular action. Compare it with automatic writing, in which one's hand traces mysterious texts quite without one's volition and quite foreign to one's state of mind. Compare it with the fact that three or four people can push a table all around a room without the slightest idea that they are pushing it at all. The E. R. A. technique is such as to leave the gravest ground for suspicion that it works—when it does work—in just this way.

Its weak spot is not made clear in the literature of the system that is designed for public consumption. The layman gets a picture of the Abrams practitioner applying the apparatus to the patient and reading off the results from a dial, a scale, or some other recording mechanism. If it were so, of course, subconscious manipulation by the doctor would play no part. No matter what the state of our subconsciousness, we cannot make the thermometer or the scales give us a false record.

But the Abrams practitioner does not have an instrument that makes its own readings. He has to set the indicator to a *given index;* then he goes through a procedure which in effect answers "yes" or "no" to the implied question whether *that rate* is present. And the means of getting the answer is itself objectionable, in that it consists merely in the doctor's getting a certain sensation. It takes the form of a changed tone on tapping the reagent's abdomen, or a sense of greater or less roughness as the finger tips are passed over his skin, or the degree to which a glass, rubber or wooden rod sticks when thus passed.

(*Continued on page 214*)

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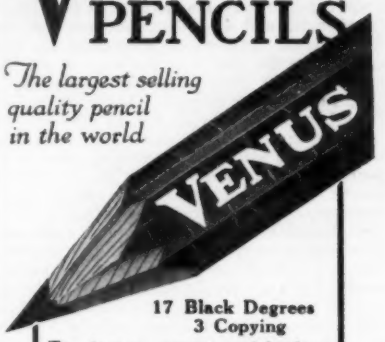

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Send for this Bulletin it is FREE POSTPAID

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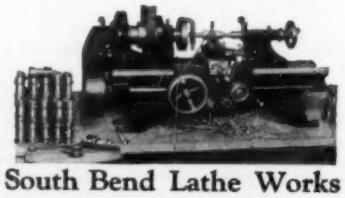
SIZE	Quick Change	Standard Change
9″ x 3′	$231.00	$201.00
11″ x 4′	278.00	238.00
13″ x 5′	344.00	294.00



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Get this, men—

A complete assortment of the world's finest smoking tobaccos — sent to any smoker anywhere — *on* 10 *days approval*

A new idea for Pipe-Smokers: 12 famous tobaccos, packed in a handsome Humidor —shipped to you direct to help you find the soul-mate for your pipe.

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Imperial Cube Cut (Medium)	.30
Imperial Cube Cut (Mild)	.30
Old English Curve Cut	.15
The Garrick	.30
Carlton Club	.15
Yale Mixture	.25
Three Slates	.25
Lone Jack	.10
Will's Latakia	.45
Louisiana Perique	.25
Total	$3.05

But through the Humidor Sampler you get a liberal "get acquainted" quantity of each for $1.50

But we are getting ahead of our story.

The average pipe-smoker is the greatest little experimenter in the world. He's forever trying a "new one," confident that some day he'll find the real affinity for his pipe.

Knowing smokers as we do—and knowing tobaccos as we do—we felt that we'd be doing a friendly turn for everybody if we found a way to settle this question once and for all, to the satisfaction of every smoker.

So we created the *Humidor Sampler*.

Into a bright red lacquered humidor case, we have packed an assortment of twelve famous smoking tobaccos—covering the whole range of tobacco taste.

To test these 12 tobaccos is to go the whole route in delightful pipe tobacco experience, trying out every good flavor and aroma known to pipe connoisseurs.

There are myriads of different *brands* of smoking tobaccos on the market. But of them all, there are 12 distinctive blends which, in our opinion, stand in a class by themselves for superlative individuality of flavor, aroma and smooth, sweet, even quality.

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Send no money. Just sign and mail the coupon. That will bring you the Humidor assortment direct from our factories to your den. When the postman brings the package, deposit $1.50 with him, plus postage.

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Simply return the Humidor, and you'll get your $1.50 and the postage back *pronto*—and pleasantly. The coupon is your obedient servant; use it.

Send No Money—Just Mail Coupon

The American Tobacco Co., Inc.
Marburg Branch, Dept. 68
Baltimore, Md.

Please send me, on 10 days' approval, one of your Humidor Samplers of twelve different smoking tobaccos. I will pay postman $1.50 (plus postage) on receipt—with the understanding that if I am not satisfied I may return Humidor in 10 days and you agree to refund $1.50 and postage by return mail.

Name.....

Address.....

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For Comfort, Convenience and Economy

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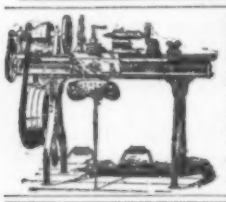

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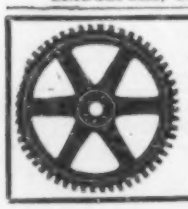

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Our Abrams Investigation—VI

(*Continued from page 212*)

When the practitioner sets his rheostat switches for a given rate, he knows precisely what he is trying for. The very fact that he sets for one rather than another rate means that, consciously or subconsciously, he has guessed that the patient has or has not a certain ailment. The very fact that he knows the patient's history from the statement accompanying the blood specimen, or that he has the patient there before him, makes it impossible for him to try one rate after another without the conscious or subconscious knowledge that the facts lean toward this finding and away from that one. Finally, under the Abrams doctrine pretty much everybody has syphilis and one or two other certain things. How can he help getting the reactions when he knows that he "ought" to get them, and failing when he knows that he "ought" to fail?

The collateral aspects of the matter support this viewpoint strongly. The reactions are very uncertain: sometimes positive, sometimes merely a matter of guessing one way or another. The state of mind of the diagnostician has much to do with his findings. Though it may have taken him six months to acquire the ability to "get" the reactions, he may lose this ability, temporarily or permanently, over night—especially if he begins to doubt the technique. A spectator with a skeptical turn of mind is apt to drive the reactions away, especially if he voices his disbelief (the psychic member of the staff interrupts to remark "Where have I heard that before?") When the blood specimens or germ cultures are known to the diagnostician, the reactions are positive, clean-cut and readily elicited; and he can get the same reaction out of the same specimen time after time. With unknown specimens of either sort the reactions become weak and uncertain; they cover a wide range quite after the shot-gun findings of Dr. X in our one formal test; and a shuffling about of the specimens, followed by their presentation in a new order, finds the practitioner unable to duplicate the results of a moment ago.

All this gives the strongest grounds for asserting that the whole thing is psychic—a trick of the subconscious mind, puzzling to the layman but clear as crystal and familiar as daylight to the psychic investigator. Persons close to Abrams have always contended that, whatever else be said about the man, he was sincere. He believed in what he did. When the reactions failed him he was always keenly disappointed and plainly bewildered. And this happened with sufficient frequency so that he knew he could not submit the reactions to a scientific test. And it is our present belief that he knew the psychic nature of the whole procedure, knew that the diagnostician got out of the apparatus only what he put into it. He knew, we believe, that he himself was the "electronic reactions," just as any other honest E. R. A. practitioner is his own "electronic reactions." This phase of the matter is now receiving our closest study, and we shall probably have more to say on it in a later article.

In his letter of January 7th, Dr. Abrams went on to ask that we publish the findings of the International Hahnemannian Association which sent two of their committee to San Francisco to stay with Dr. Abrams for two months, in order to master the technique and pass judgment on its value. The report of the findings of that worthy body is an interesting document. It describes the technique and its results. It admits the existence of the so-called electronic reactions and their applicability to diagnostic work, but with several reservations. By no means does this report accept the Abrams method as a perfected product.

Now that request of Dr. Abrams was fair enough. When the report of the International Hahnemannian Association first came to our attention, we were deeply impressed. That association is to be commended on the scientific and business-like manner in which it has investigated the claims of Dr. Abrams, and more particularly his method. We immediately got in touch with the very men of the International Hahnemannian Association who had investigated E. R. A. and made the report. And since then, over a period of several months, we have been working with them in their experiments with the so-called electronic reactions. At this state of the experimentation, it would be unwise for us to publish the original report, in that it is to be modified by subsequent reports of that association, and in that much remains to be done before a final opinion can be passed on this matter.

It has been said of Dr. Abrams that he could measure the span of life of any individual by means of the electronic emanations from a blood specimen. He measured his own span of life, and he is reported to have predicted his death during January of this year. That may be true. However, it seems strange that he should have closed his last letter to us by stating that he would probably not get to New York until some time in the Spring.

Dr. Abrams is no more. His teachings are in the hands of some three thousand or more practitioners in this country alone. Several experimenters are spending large sums of money and unlimited time endeavoring to discover the mysterious energy at the bottom of E. R. A. technique. With the interesting and baffling personality of Dr. Abrams no longer available as the foundation for the entire E. R. A. edifice, no longer available as a buffer against investigation, the truth must soon be discovered since it is the technique itself which must now stand or fall.

The Chemistry of Bread

THE Food Research Institute in its first publication just issued from its headquarters at Stanford University points out the wholesomeness of the stale loaf, shows the waste produced by present bakery practices and urges further investigation of the question as to why some bread keeps better than others.

The assumption that staleness is caused by the loss of moisture from the loaf is not tenable, for the report points out that what probably occurs is that much of the moisture in the bread is held by the starch which has been gelatinized in the baking. As the loaf comes out of the stove, this starch jelly distributed through the bread contains all the moisture it can hold. As the bread cools, the starch gives up some of its moisture, and this moisture is absorbed by the other constituents of the loaf, changing the crust from a brittle material that crunches between the teeth to a soft and pliable one, while the gluten of the crumb is given a toughness and firmness which as fresh bread it did not have. The bread becomes stale at low temperatures and this accounts for the fact that bread when stale, but not dry, can be freshened up by heating. The process is reversed and the starch-jelly reabsorbs the moisture from the other bread constituents.

"Thirty Years of Psychic Research"

(*Continued from page 160*)

excellent translation by Fournier d'Albé gives assurance that here, as with Mr. de Brath's rendition of Richet's book, knowledge of the subject as well as of the language has had full play.

The case of Eva C. has been a much controverted, and a bitterly controverted, one. The present book will not clear it up to the satisfaction of all, because the Baron plainly does not entertain as seriously as the investigator ought, the hypothesis of fraud. He even shows excessive naiveté in the presence of what can fairly be characterized as strong evidence of fraud. Thus, when one of Eva's "materializations" carries on its face a page-heading from "Le Miroir," the journal from which Eva is charged with having clipped pictures for use in this fashion, the Baron records the fact with the very extraordinary remark that he has no explanation for it. Nevertheless, this is the first approach to a complete account of Eva's mediumship that has appeared, and it is of great importance. Every serious student of psychic matters ought to read it and form his own ideas of the evidence for materialization, which we think, for the present at least, must rest largely upon Eva. Even the general reader, though he would probably tire if he attempted a close examination of every page, will find it well worth while to make a first-hand acquaintance with this interesting episode in psychic investigation. Not the least important feature of the volume is that, in this English edition, there is included the Baron's rejoinders to much of the newspaper criticism which flowed so freely upon publication of the first German edition. It is only fair to say that much of this criticism displays the same haste and the same ill-consideration which it charges against the Baron. Schrenck Notzing, by the way, like Richet, rejects the spirit hypothesis—though he does so rather more tentatively than Richet; and like Richet, he has no very well formulated alternative to offer in its stead. We make this remark with no critical intent; it rather well represents our own present state of mind, too.

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Seventy-Ninth Annual Statement

TO THE POLICY-HOLDERS:

As a policy-holder you are chiefly interested in the quality of your Company and in the service it renders. By "quality" I mean the character of its business; the grade of its securities; the standards maintained by its Executive Officers.

I can not paint a complete picture, but in order to drive home some of the truth I give you below a picture of the work of **one Committee** during the year 1923.

During 1923 the Finance Committee made the following investments:

BONDS PURCHASED	Cost	Average Yield
U. S. Government Treasury Notes	$11,013,860.00	4.65%
Domestic Railroad Bonds	13,569,960.00	5.44%
Domestic Municipal Bonds	4,050,912.00	5.02%
Domestic Public Utility Bonds	9,216,596.00	5.49%
Canadian Municipal Bonds	494,700.00	5.24%
British and Other Foreign Bonds	5,470,312.00	5.14%
Total	**$43,816,340.00**	**5.17%**
BOND AND MORTGAGE LOANS MADE		
City Loans	$59,262,432.00	5.81%
Residential Loans	10,002,094.00	5.80%
Farm Loans	18,097,561.00	5.38%
Total	**$87,362,087.00**	**5.72%**
Bonds bought and B. & M. Loans made	$131,178,427.00	5.54%
B. & M. Loans renewed	$12,991,730.00	5.50%
Total	**$144,170,157.00**	**5.53%**

This total—**$144,000,000.00**—was much more than our net income. The Committee believed it saw an opportunity to benefit you through selling and reinvesting, without risk, in order to increase the earning power of invested assets. They therefore sold Bonds amounting to (par value) **$44,845,459.29** during the year, of which **$33,182,900.00** were United States Government Bonds. By this process, and by transferring of certain foreign bonds, in reinsuring foreign business, they increased the earning power of Ledger Assets by over **$1,000,000.00** annually for **an average of nine years.**

In addition to the Finance Committee we have five other standing committees and several sub-committees. They all work. The standing committees make detailed reports to the Board of Directors monthly. The members of the Board are in close touch with matters of fact as well as matters of policy.

The new business in 1923 was	$693,000,000.00
The gain in outstanding insurance was over	$300,000,000.00
The total insurance outstanding is	$4,300,000,000.00
The admitted assets, at **market values,** aggregate	$1,003,773,000.00
The unassigned surplus is	$69,500,000.00

We have 125 Branch Offices in the United States and Canada, to which over 8,000 agents report.

DARWIN P. KINGSLEY, President.

Balance Sheet, January 1, 1924

Bonds at MARKET VALUE, as Determined by Insurance Department, State of New York

ASSETS		LIABILITIES	
Real Estate Owned	$7,774,440.00	Policy Reserve	$800,574,178.00
First Mortgage Loans—		Other Policy Liabilities	24,620,009.06
On Farms	66,239,961.23	Dividends left with Company to Accumulate at Interest	13,851,238.99
On Residential and Business Properties	189,255,218.65	Premiums, Interest and Rentals prepaid	3,244,255.04
Loans on Policies	166,267,471.04	Taxes, Salaries, Accounts, etc., due or accrued	7,729,500.32
Bonds of the United States	92,274,810.00	Additional Reserves	9,088,210.00
Railroad Bonds	283,480,416.77	Dividends payable in 1923	54,800,321.47
Bonds of other Governments, of States and Municipalities	130,950,765.53	Reserve for Deferred Dividends	20,352,917.00
Cash	6,835,903.11	General Contingency Funds not included above	69,513,132.58
Other Assets	60,694,776.13		
Total	**$1,003,773,762.46**	**Total**	**$1,003,773,762.46**

Since organization the Company has paid to and on account of Policy-holders and Beneficiaries over $2,000,000,000.00

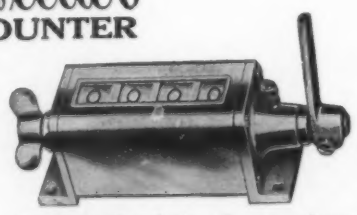
Est. LUDLUM 1854
The Quest for Superiority In a Cutting Tool
The aborigines quest for superior metals was often beset with many perils. His search led him into the reptile's den and poisonous gas pockets, but he considered it worth while.
Today his crude ores and metals are made into myriad servants by the method of the modern man. One of the best tool steels resulting from such modern methods is
UTICA TOOL STEEL
It is an ideal steel for threading tools, master and production taps, gauges, combination blanking tools, punches, twist drills, reamers, broaches, form cutters or wherever a hard, keen, durable cutting edge is desired. It is very free from any tendency to warp or twist, crack or check when quenched in oil.
The National Carbon Company, Inc., of Cleveland says: "Your Utica steel for blocks where they are subjected to 4500 lbs. to the square inch stand the gaff forever."
May we talk over your tool steel requirements with you?
See our many other wonderful steels
LUDLUM SPECIAL STEELS LUDLUM STEEL COMPANY
STEELS SPECIAL PURPOSES WATERVLIET · N.Y. U.S.A.

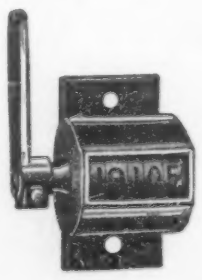
Added Production, Only!

Counters on your machines *ADD* the output—and mean added output for this reason: They bring the sum total of work to your *attention*, when all it needs is attention to "jack it up!" Production-*gains* are all you countenance—and all you *see* when you read the operator's record on a

Veeder COUNTER

The large Set-Back Revolution Counter at right is less than ¾ actual size. The small Revolution Counter below is shown nearly full size.





The Set-Back Revolution Counter above records the output of the larger machines where the revolutions of a shaft record operations, or output. Counts one for each revolution, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price, with four figures, as illustrated, $10.00 (subject to discount).

The Small Revolution Counter at left records the output of smaller machines where a shaft revolution indicates an operation. Though small, this counter is very durable; its mechanism will stand a very high rate of speed, making it especially adapted to light, fast-running machines. Will subtract if run backward. Price, $2.00.

There's a VEEDER to fit every machine—and every need in your development-work. The Veeder booklet shows 80 pages of counters; write for this free guide to greater production.

The Veeder Mfg. Co., 18 Sargeant St. Hartford, Conn.

The Story of Steel—III

(*Continued from page 163*)

their share in building up this wonderful system of Lake transportation. Their most notable work, outside of the provision of lighthouses and the dredging of harbors, has been done at and around the rapids of St. Mary's River, where they have dredged and blasted some 45 miles of canal, with a least width of 300 feet and a minimum depth at low stage of 21 feet. Other notable work has been the construction of a series of locks, two of which are the longest in existence. These include the Weitzel Lock—515 feet by 80 feet; the Poe Lock—800 feet by 100 feet; the third lock 1350 feet by 80 feet, and the fourth lock of the same dimensions. The various channels approaching the locks, through St. Mary's River and elsewhere, are excellently lighted, and the captains of the ships, through long familiarity, navigate these channels, even in very foggy weather, with an accuracy and absence from grounding or collision that is positively uncanny.

We reached the easterly end of Lake Superior at night, and in thick weather, and therefore anchored outside the canal. During the night the stream of traffic coming up behind us halted also, and when day broke and the fog lifted there were some eight or ten big freighters, fully loaded, bunched around us. We tied up alongside the pier awhile, until two big 12,000-ton ore boats which were in the lock had steamed out. We then entered, being followed by another ship of our own size. Two other vessels occupied No. 4 lock and, as showing the immensity of this traffic, the writer noted from the pilot house that, including the ships in the locks, those waiting to enter at each end, and those which had passed through and were starting to the eastward or westward, there was an aggregation of ships which the captain estimated to total over 150,000 tons in capacity.

We have said that navigation is totally different on the Great Lakes, and certainly the end of our journey bore out this statement; for we proceeded, in spite of our length of over 600 feet, to steam up a narrow, winding creek averaging 250 feet in width, and with turns of 90 degrees to our destination, the Lorain Steel Works, where we were to discharge. A powerful tug at the bow, a series of alternate full-ahead and full-astern telegraphs to the engine room, combined with an amazing amount of churning up of soft mud, landed us finally at the great ore docks of the company. Before we tied up alongside, the hatch covers had all been opened and four Hewlett unloaders, moving into position on the concrete wharf, spaced themselves along our 400-foot length of cargo hold.

These unloaders are one of the most amazing mechanical contrivances of all the many amazing things connected with the United States steel industry. I was standing amidships, looking down into one of the holds, when a voice from the air called out "Good morning, did you have a fine passage?" and looking up I saw the huge grab bucket and the vertical bucket leg of an unloader descending to enter the hatch. The voice was from the operator of the grab, who, as will be seen from our illustration, has his cabin inside the "bucket leg" and a few feet above the bucket. As he passed me he pulled a lever, and the two halves of the bucket swung apart until the opening was over twenty feet. Down sunk the great mass deep into the pile of ore below. Another lever was pulled and the jaws crunched together, and the operation of a third lever caused the whole leg and bucket, with its load of ten tons, to rise vertically into the air. Then the grasshopper-like, double walking beam moved back until the bucket was within the pier line, when it opened and let its contents fall into a hopper and thence into a lorry, which immediately was drawn inshore upon the framework of the unloader to discharge itself into ore cars on the tracks below. The walking-beam section of the unloader then moved forward again until the bucket leg was over the hatch, when it descended for another grab. I timed the operation and found that the cycle took just one minute.

This was a ten-ton unloader, but some of the later and larger machines are capable of picking up 17 tons at one grab, and with this in mind it can be understood how the records of unloading mentioned above in this article were achieved.

Thus, we have followed the ore from the time when it was dug out of the Hull Rust pit to the time when it was deposited in the stock pile alongside the blast furnaces, 800 miles distant. At the rate of 16 tons for each scoop it was torn loose from its age-long resting place in the ore body; and at 17 tons to the grab it was picked up and brought ashore at the end of its long journey by water.

More Steam-Engine Power Without Steam

(*Continued from page 168*)

one-half minutes for the new liquor to be heated up to a pressure of 20 pounds per square inch as read off the pressure gage. The engine was started running and the pressure then fell to about 18 pounds per square inch, but stayed there during the entire course of the experiment, going up slightly as load was put on the engine. The engine ran perfectly and even after 18 weights had been placed on the beam pan, it still continued running.

The conclusion must therefore be drawn that the new power medium will develop six times as much power as steam under constant conditions. It was interesting to note that the exhaust from this engine was direct to the air, and in the case of the new liquid it was almost in the form of a liquid while in the case of steam it was hot vapor. Furthermore the engine itself was perfectly cool when run with the new power medium but rather hot when run with steam.

There have been quite a few uses suggested for the new power medium. In general it may be said that it will find a field in every phase of power generation. Thus it has been suggested that it can be used in central station plants for developing power, in city water and sewage pumping stations. It has an application to marine transportation. Railroad locomotives and cars can be run with it. It may be applied for generating power in mines, mills, factories, quarries, sawmills, cranes, etc., on the automobile, in airplanes and airships, where its non-inflammability would be extremely advantageous, for driving ice machines—there are in fact innumerable possible applications.

In closing it may be said that this report was written as a corollary to an investigation made to determine if the claims of the inventor were really true. What has been seen convinces the writer that this new liquid will actually develop a vapor which will run a turbine or a reciprocating engine. Furthermore, it will do so in a closed system wherein the same liquid is used over and over again. As far as could be determined this repeated use of the same liquid does not result in its decomposition. Finally, it appears that more power is generated at less heat in comparison with steam.

Laying the Ghost of a War-Time Trouble

(*Continued from page 180*)

war debts of one sort or another of tens of billion dollars are trifling. It means that either we must grow more foodstuffs, and not only completely feed ourselves, but export replaceable foodstuffs to maintain our foreign trade balance, or that we will lose our prosperity, and our standards, which are the highest in the world, will sink to the lower level of those of foreign countries. Uncle Sam's new lands of the West are gone; our old lands are wearing out. The productivity of our American soils must be restored by every possible means. To restore these soils requires just three elements, no more; phosphorus, nitrogen and potash. Of phosphorus, we have in the vast phosphate deposits of the West, an inexhaustible supply, the greatest in the world. Of nitrogen, there is an inexhaustible supply in the air; it can be captured by such mechanical means as at the Muscle Shoals plant, and by nature working through the clovers, sowpeas and other leguminous plants which by strange bacteriological action condense thousands of tons of it annually—so that there is no shortage of these two elements. Potash is then the key. Our practical men of science believe that we have this key; that it exists in the shape of millions of tons of soluble potash salt deposits in the Southwest. The interests of the people, whether the people realize it or not, demand early and reliable information as to the exact location, size and richness of these beds. If the question of the manufacture of nitrates at the Muscle Shoals or other plants is one for the politicians and the farmers of the country to get moderately stirred up over, the question of locating American potash salts deposits is one that is worthy of a revolutionary uprising. The drilling of wells using core drills which will show just what is being drilled through, and, when the beds of potash are struck, just how thick they are, is imperatively needed.